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(12) **United States Patent**
Turner

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(45) **Date of Patent: Mar. 1, 2016**

(54) **CUSHIONING ELEMENTS FOR APPAREL AND OTHER PRODUCTS AND METHODS OF MANUFACTURING THE CUSHIONING ELEMENTS**

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(21) Appl. No.: **14/193,854**

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(65) **Prior Publication Data**

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Related U.S. Application Data

(60) Division of application No. 13/035,570, filed on Feb. 25, 2011, now Pat. No. 8,702,895, which is a continuation-in-part of application No. 12/755,579, filed on Apr. 7, 2010, now Pat. No. 8,425,712.

(51) **Int. Cl.**
B32B 38/04 (2006.01)
A41D 13/015 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***B32B 38/04*** (2013.01); ***A41D 13/0156*** (2013.01); ***A41D 13/0581*** (2013.01); ***A41D 31/005*** (2013.01); ***A43B 13/187*** (2013.01); ***A43D 8/06*** (2013.01); ***A43D 8/08*** (2013.01); ***A45F 3/08*** (2013.01); ***A45F 3/12*** (2013.01); ***A47C 7/021*** (2013.01); ***A63B 71/08*** (2013.01); ***A63B 71/12*** (2013.01); ***B26D 7/1836*** (2013.01); ***B29C 65/48*** (2013.01); ***B29C 66/433*** (2013.01); ***B29C 66/472*** (2013.01); ***B29C 66/727*** (2013.01); ***B29C 66/8322*** (2013.01); ***B29C 66/845*** (2013.01); ***B29C 69/005*** (2013.01); ***B32B 5/245*** (2013.01); ***B68G 5/02*** (2013.01); ***B68G 7/00*** (2013.01); ***B68G 13/04*** (2013.01); *A41D 13/05* (2013.01); *A45F 2003/122* (2013.01); *A45F 2003/125* (2013.01); *A63B 2071/125* (2013.01); *A63B 2071/1233* (2013.01); *A63B 2071/1241* (2013.01); *A63B 2071/1266* (2013.01); *B29C 65/18* (2013.01); *B29C 65/26* (2013.01); *B29C 65/30* (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC B32B 38/04; A41D 13/0156; A41D 13/0581; A41D 3/005
See application file for complete search history.

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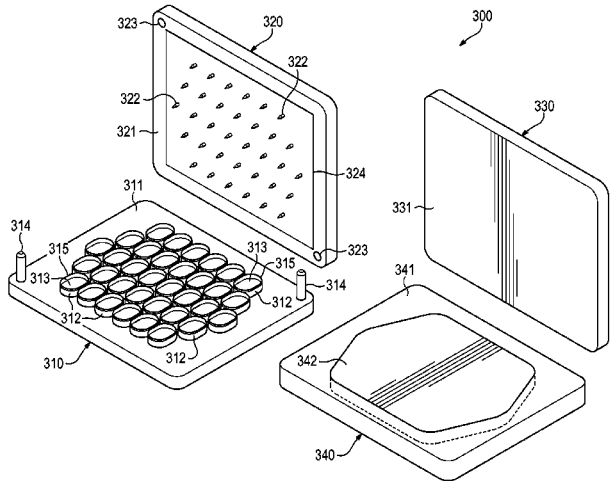
Primary Examiner — Jeff Aftergut
(74) *Attorney, Agent, or Firm* — Shook, Hardy & Bacon L.L.P.

(57) **ABSTRACT**

A method for manufacturing the cushioning elements may include utilizing a die with a plurality of die elements positioned in a particular arrangement. A polymer material, which may be a polymer foam material, is located between the die and an extractor. The polymer material is compressed between the die and the extractor, and the die elements cut the polymer material to form a plurality of pad components, which are arranged like the die elements. The die and the extractor are separated, and the pad components are secured to the extractor in the arrangement of the die elements. Additionally, the pad components are bonded to at least one material layer such that the pad components remain in the arrangement of the die elements.

20 Claims, 59 Drawing Sheets



(51) **Int. Cl.**

A41D 31/00	(2006.01)
A43B 13/18	(2006.01)
A43D 8/06	(2006.01)
A43D 8/08	(2006.01)
A45F 3/12	(2006.01)
A47C 7/02	(2006.01)
A63B 71/08	(2006.01)
A63B 71/12	(2006.01)
B26D 7/18	(2006.01)
B29C 69/00	(2006.01)
B32B 5/24	(2006.01)
B68G 5/02	(2006.01)
B68G 7/00	(2006.01)
B68G 13/04	(2006.01)
A45F 3/08	(2006.01)
B29C 65/48	(2006.01)
A41D 13/05	(2006.01)
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B29C 65/26	(2006.01)
B29C 65/30	(2006.01)
B29C 65/62	(2006.01)
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B29C 65/00	(2006.01)
B29L 31/44	(2006.01)
B29L 31/48	(2006.01)
B29L 31/50	(2006.01)
B29L 31/00	(2006.01)

(52) **U.S. Cl.**

CPC *B29C 65/4815* (2013.01); *B29C 65/62* (2013.01); *B29C 65/7841* (2013.01); *B29C 65/7847* (2013.01); *B29C 66/24223* (2013.01); *B29C 66/24241* (2013.01); *B29C 66/24244* (2013.01); *B29C 66/24249* (2013.01); *B29C 66/30326* (2013.01); *B29C 66/71* (2013.01); *B29C 66/729* (2013.01); *B29C 66/7392* (2013.01); *B29C 66/73921* (2013.01); *B29C 66/7484* (2013.01); *B29C 66/8122* (2013.01); *B29C 66/836* (2013.01); *B29L 2031/443* (2013.01); *B29L 2031/48* (2013.01); *B29L 2031/4821* (2013.01); *B29L 2031/4864* (2013.01); *B29L 2031/507* (2013.01); *B29L 2031/71* (2013.01); *B29L 2031/7128* (2013.01); *B32B 2038/042* (2013.01); *B32B 2571/00* (2013.01); *Y10T 156/1062* (2015.01); *Y10T 156/1089* (2015.01); *Y10T 156/1092* (2015.01); *Y10T 156/1093* (2015.01); *Y10T 428/24612* (2015.01)

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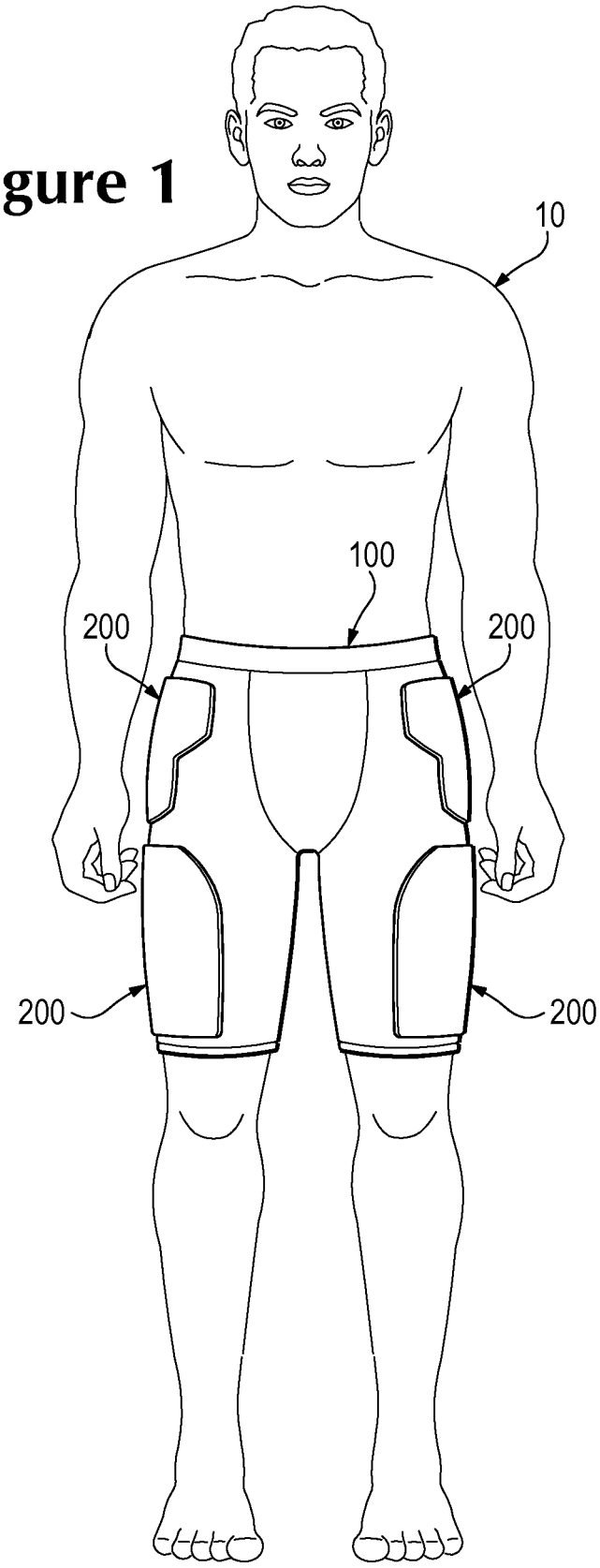
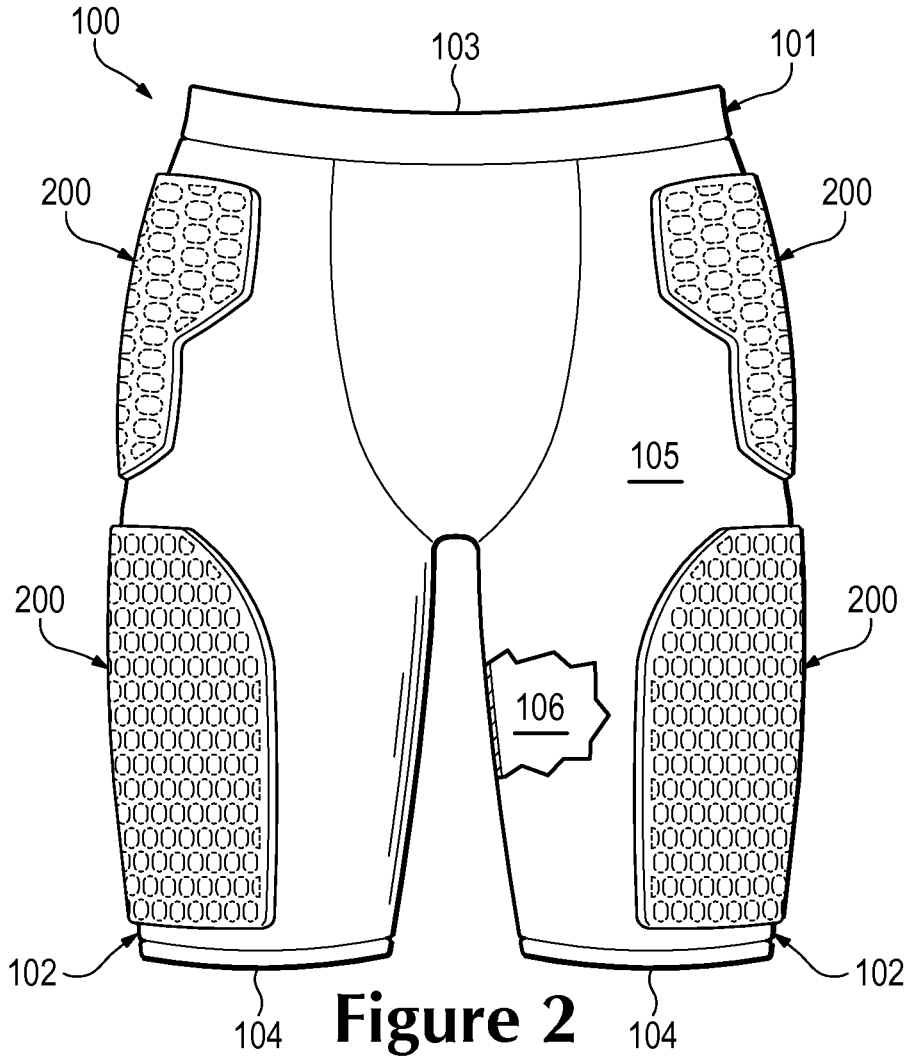
Figure 1





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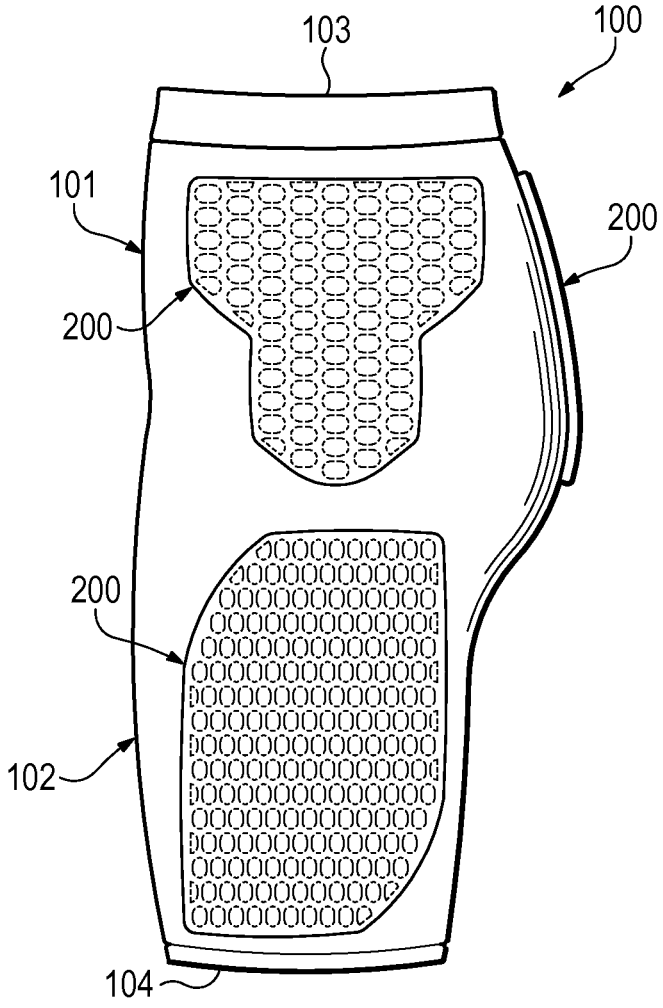

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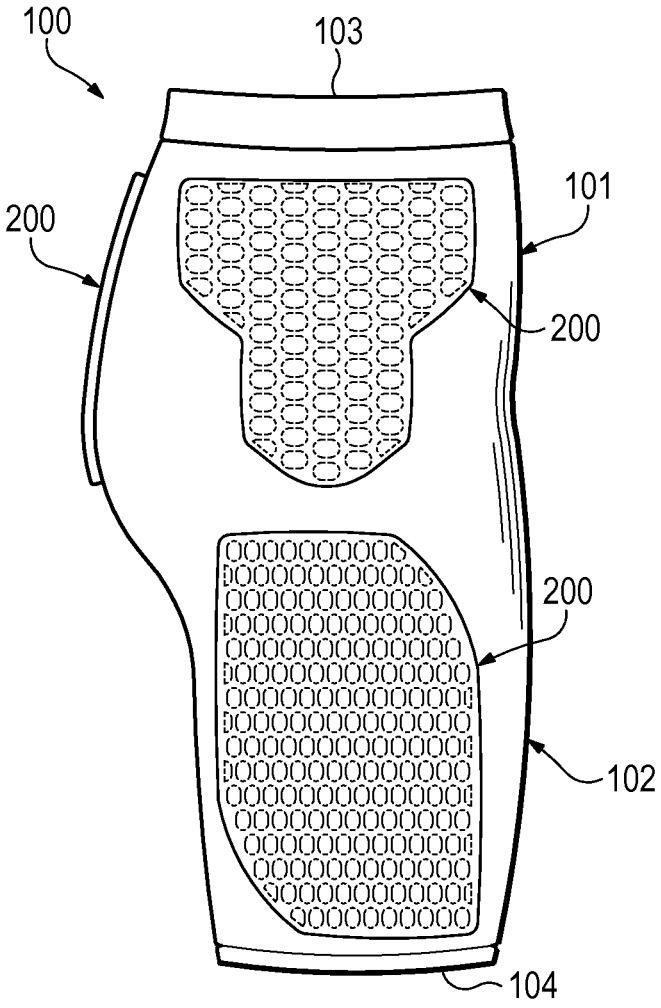

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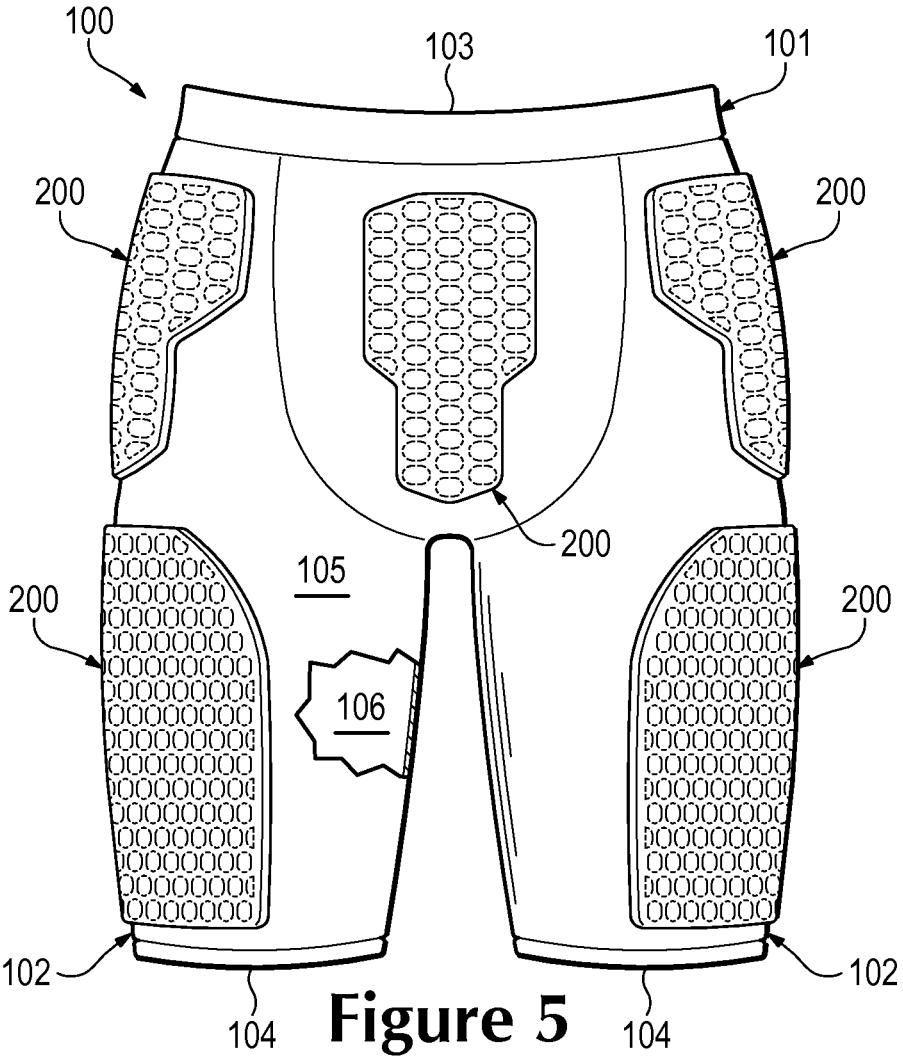

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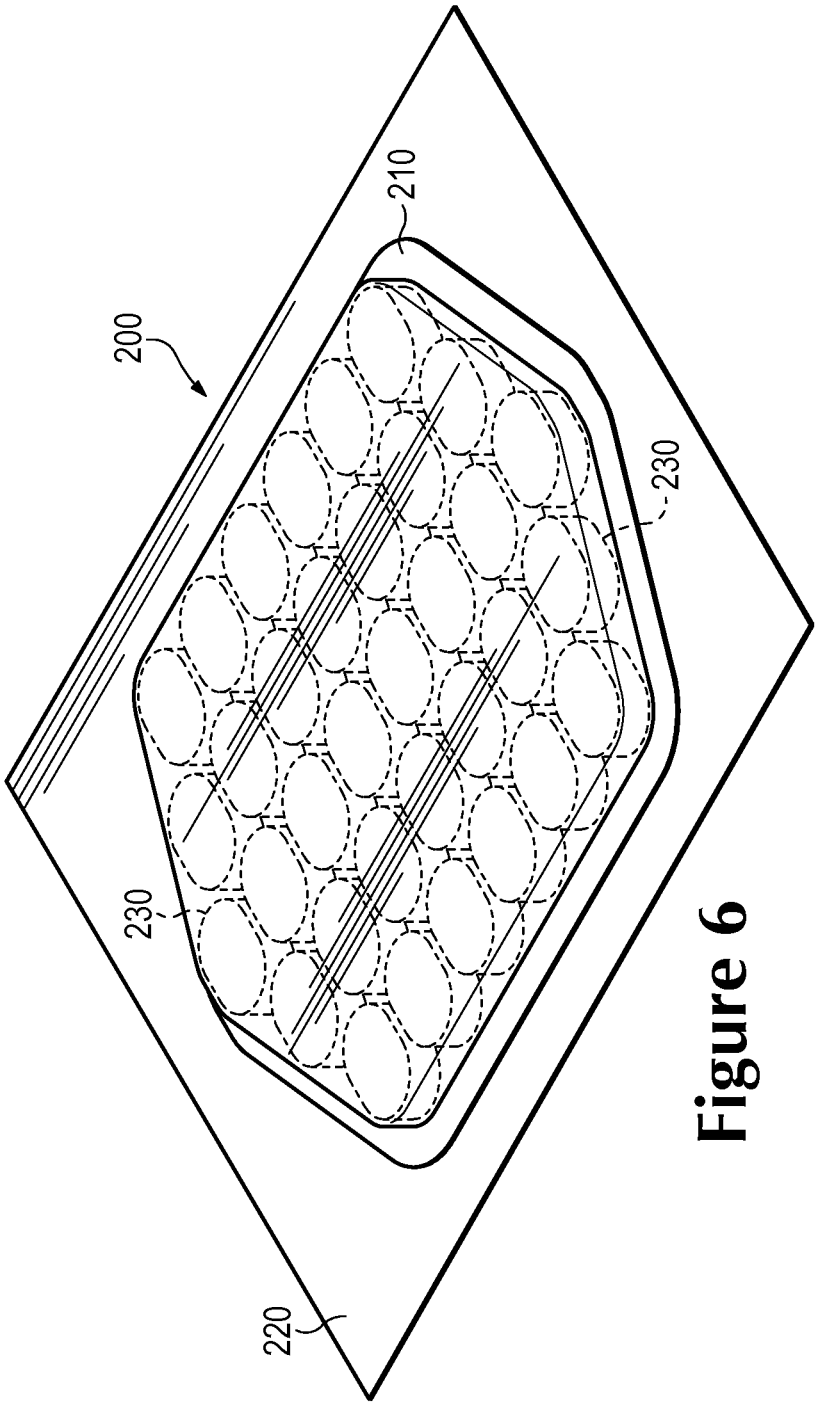

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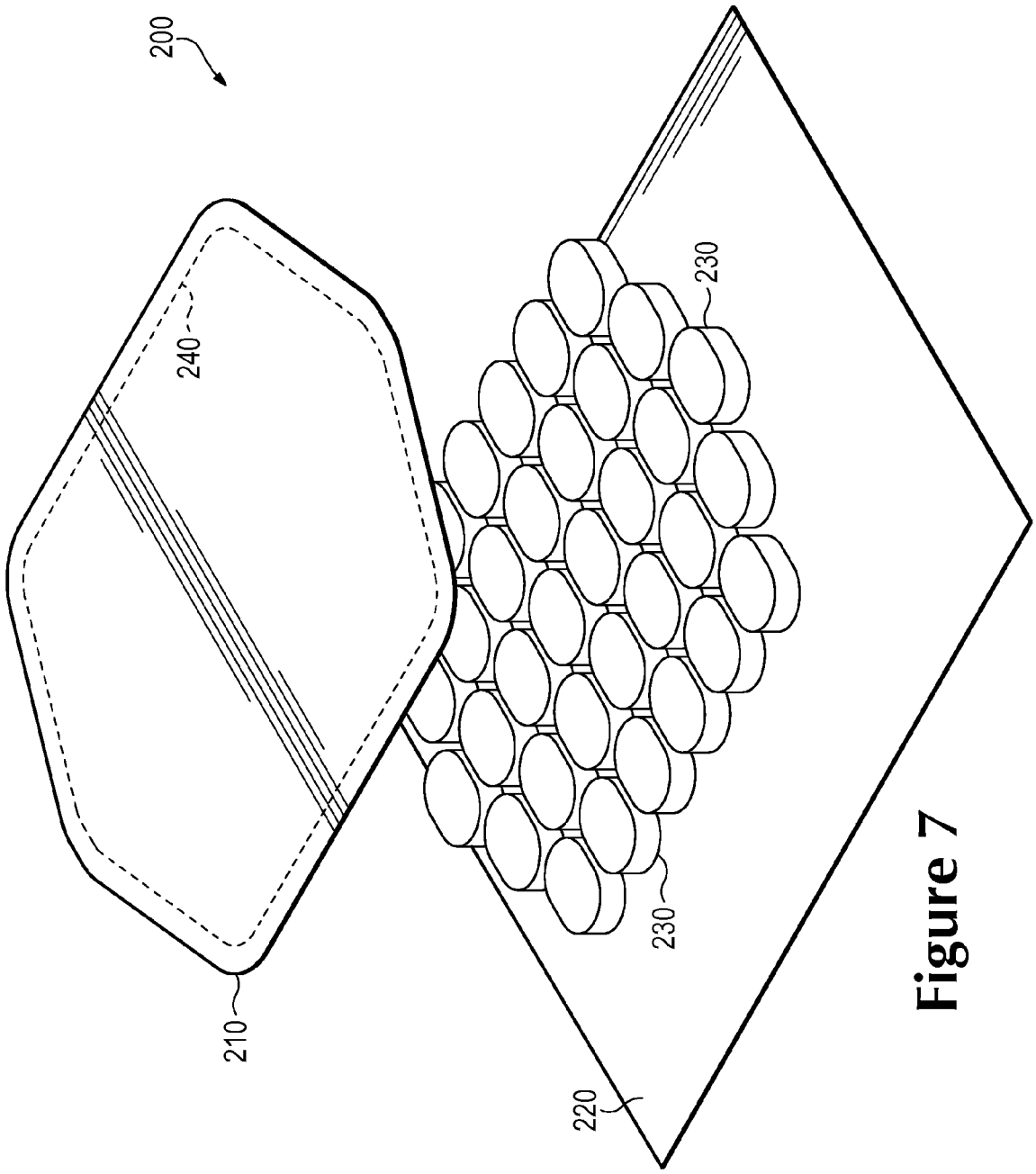

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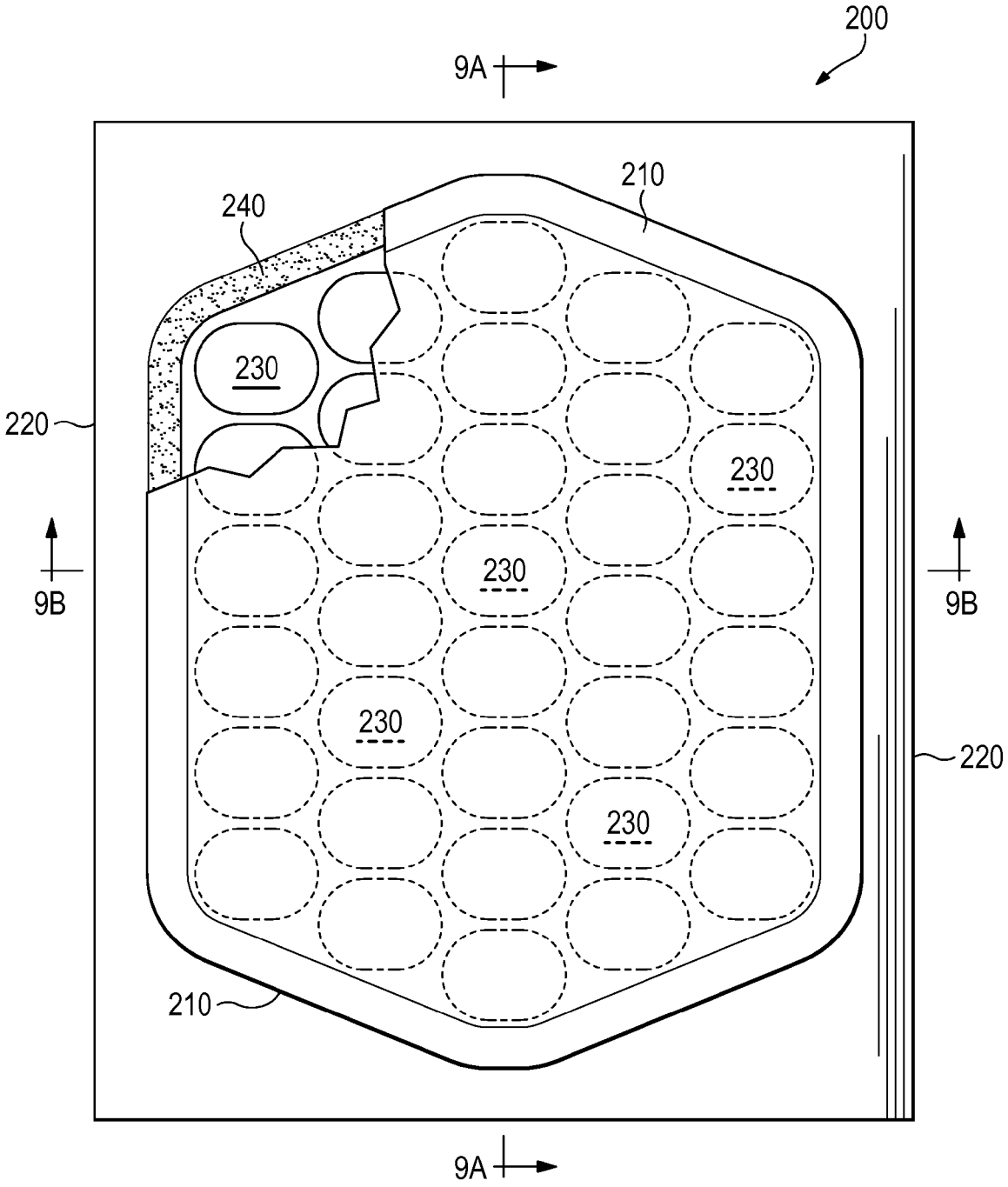

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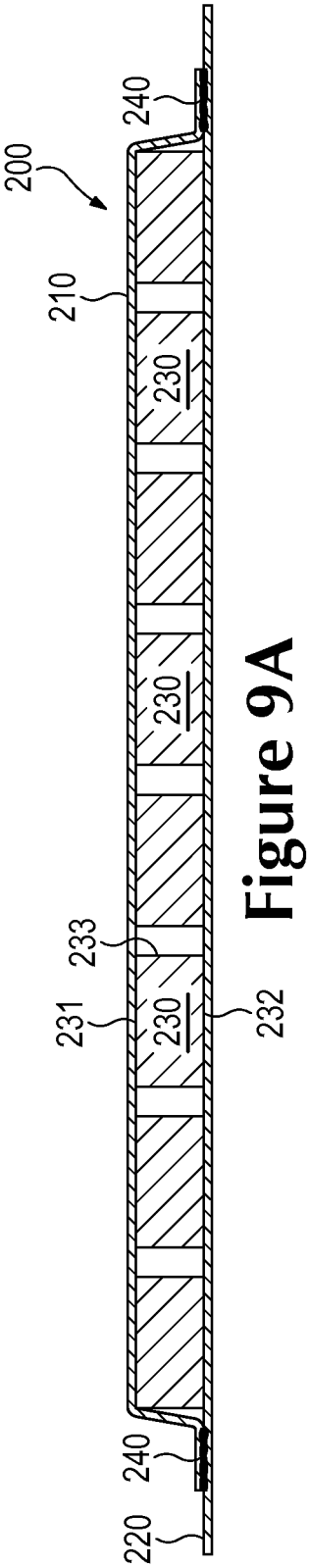

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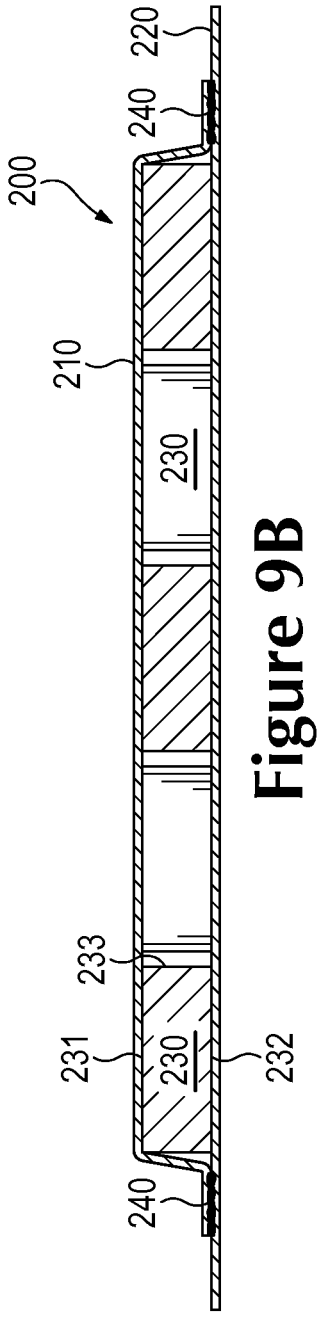

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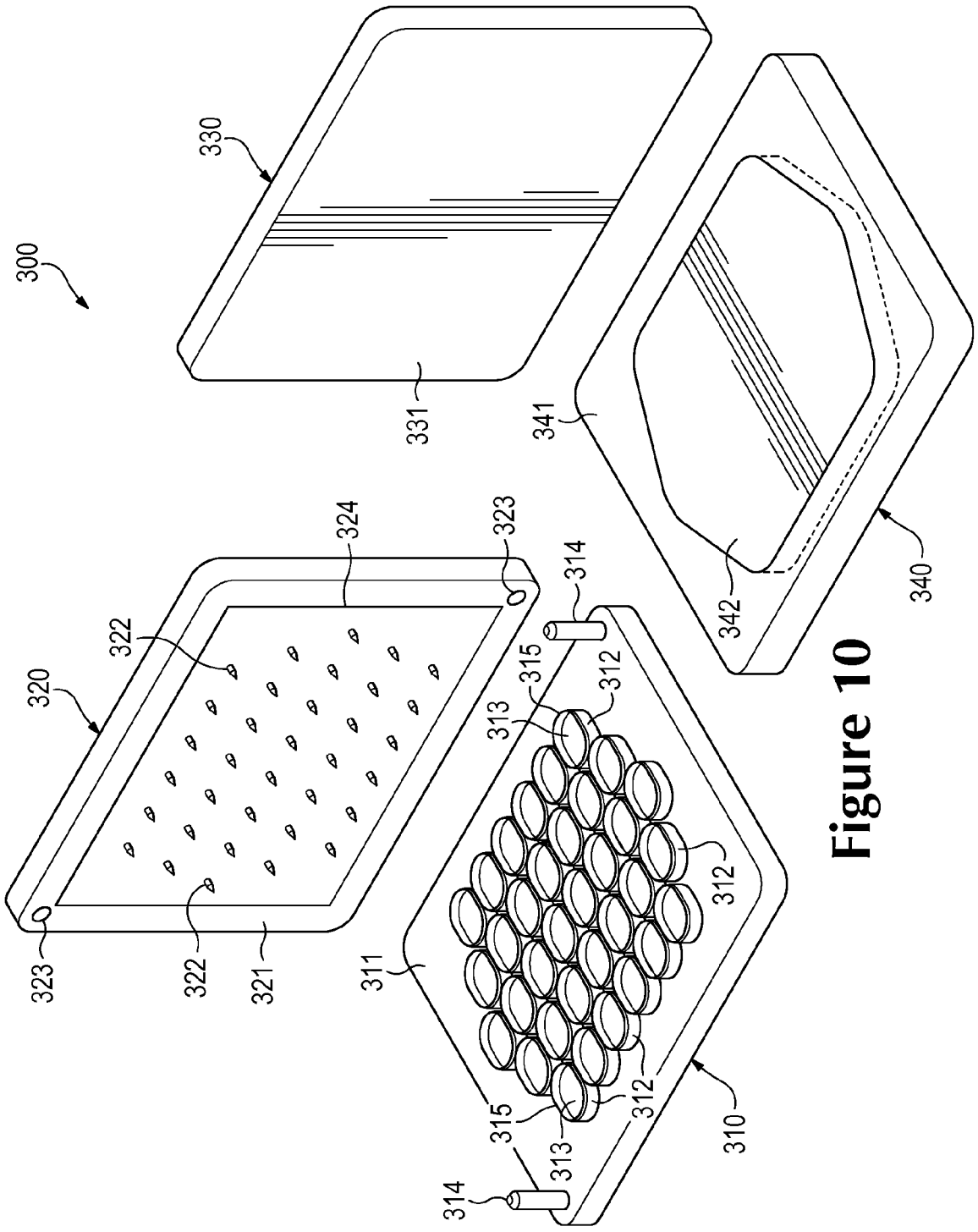

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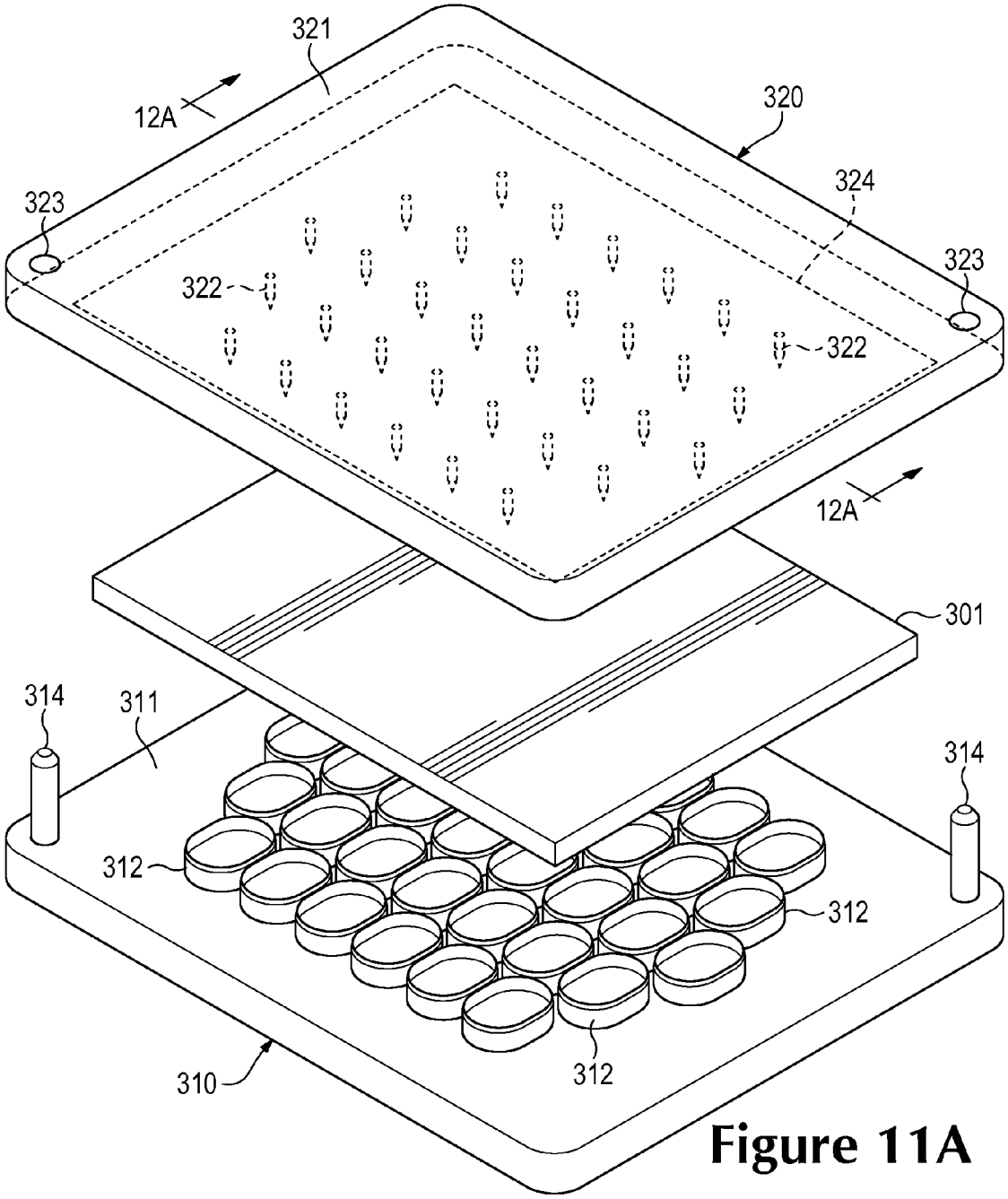
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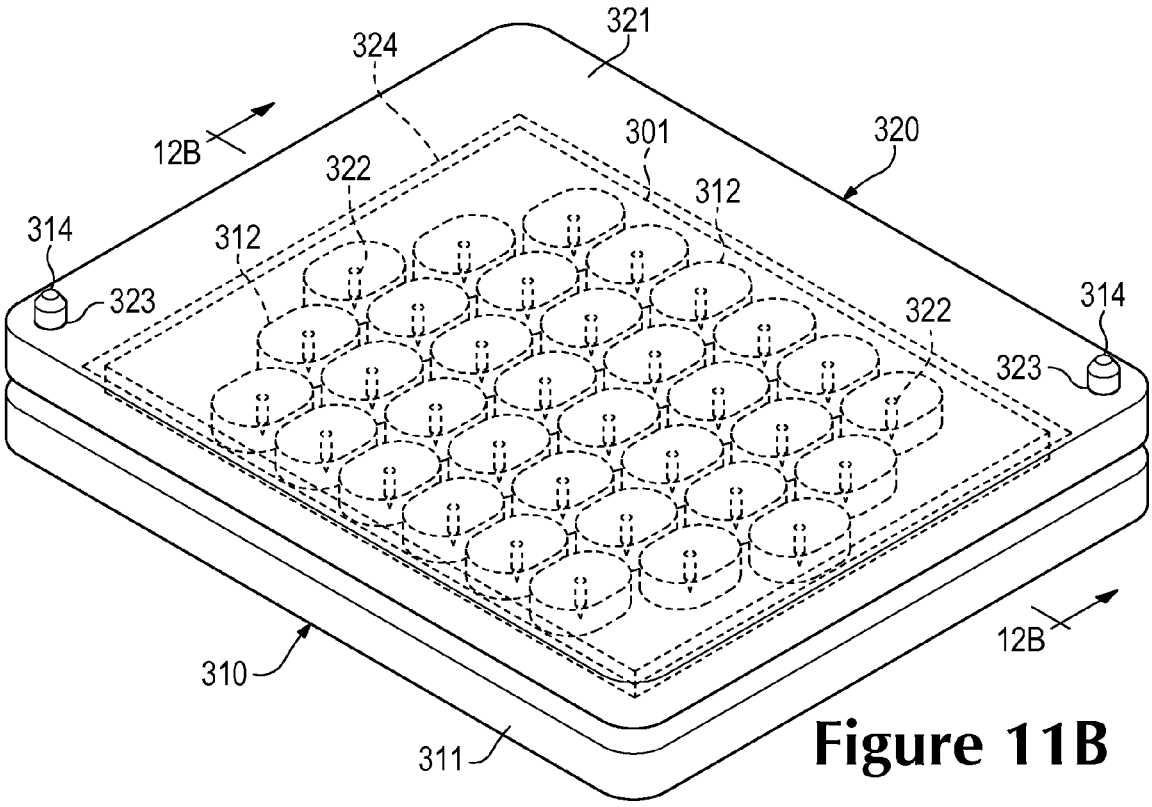

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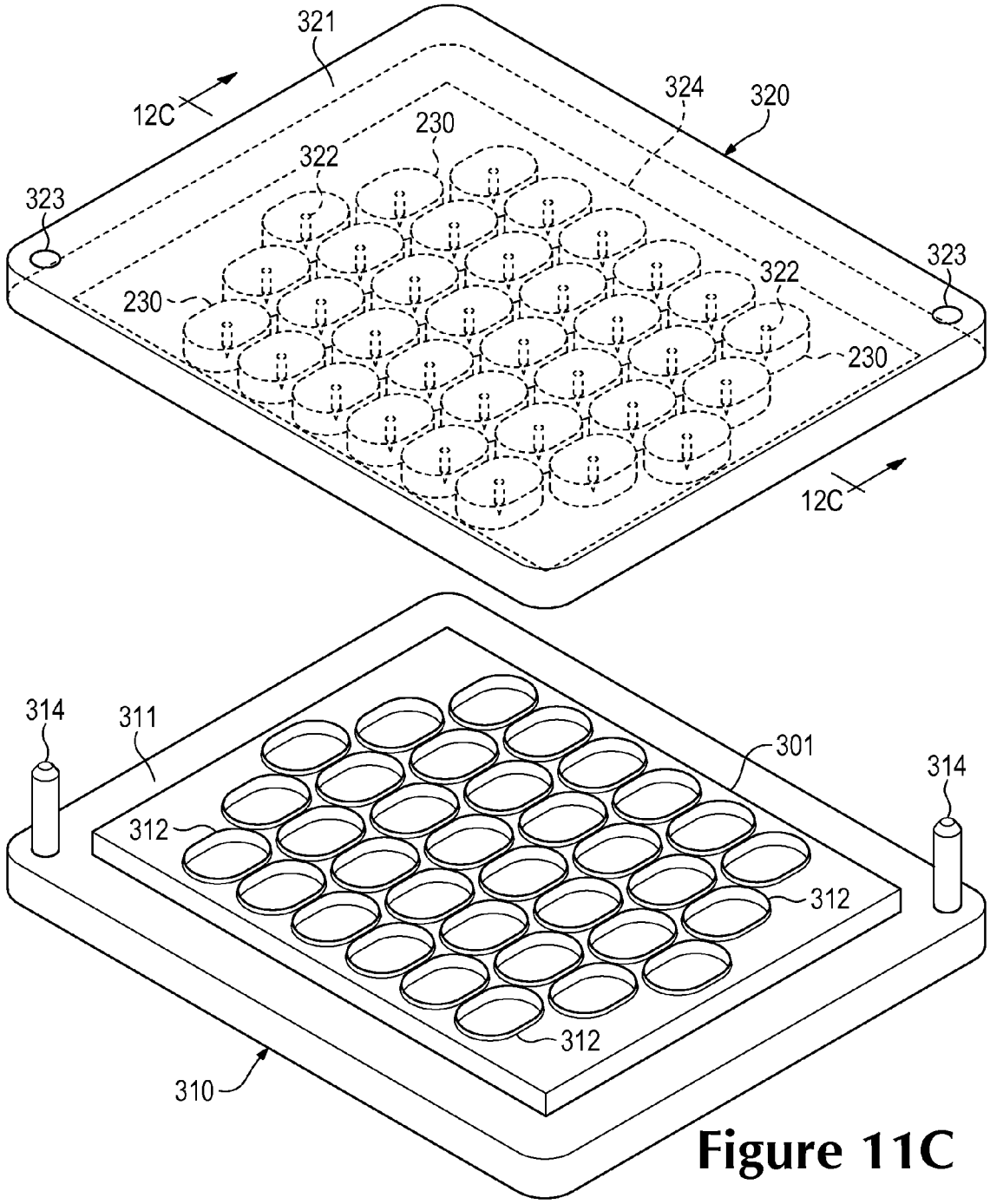
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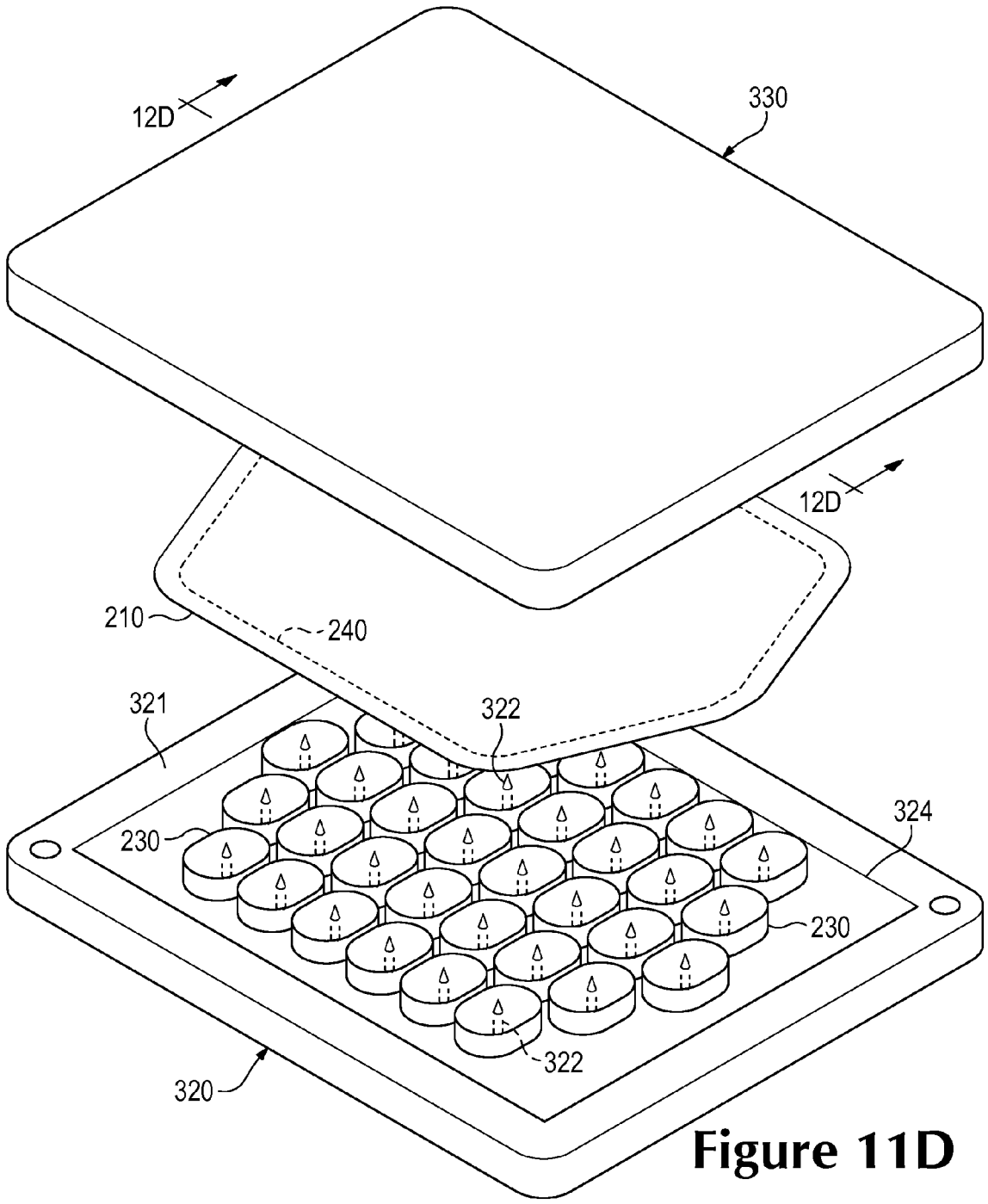

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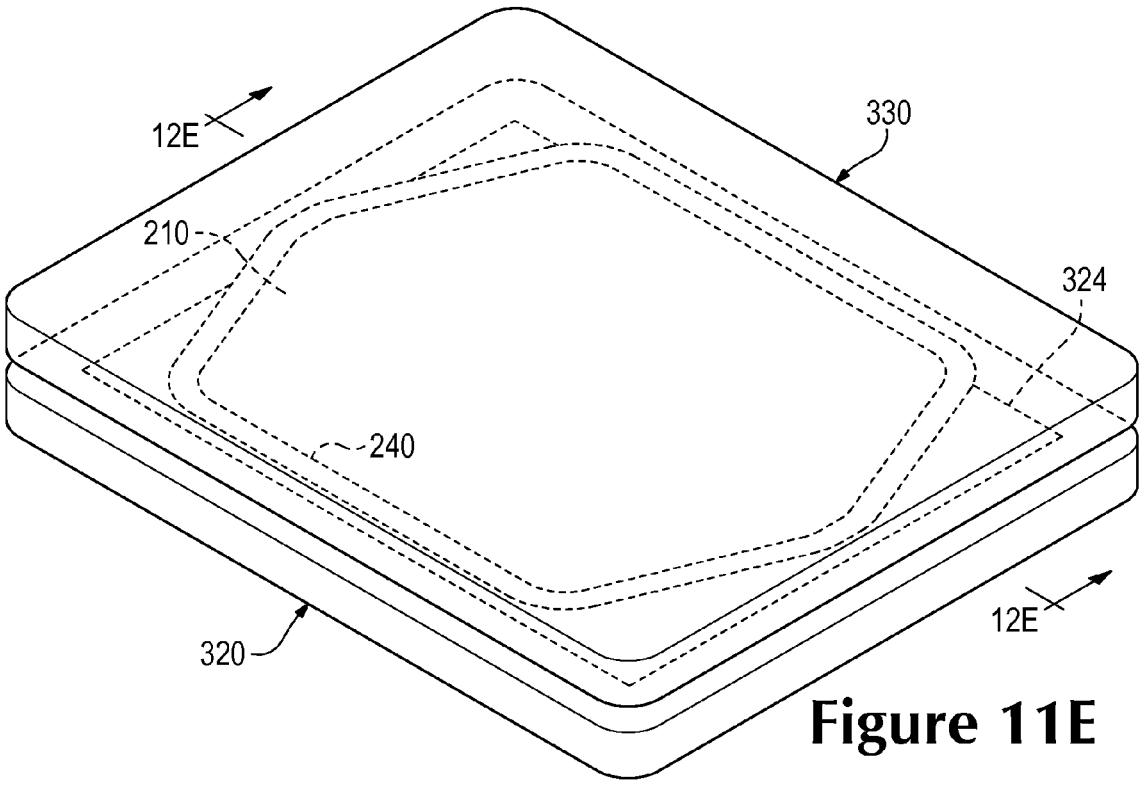

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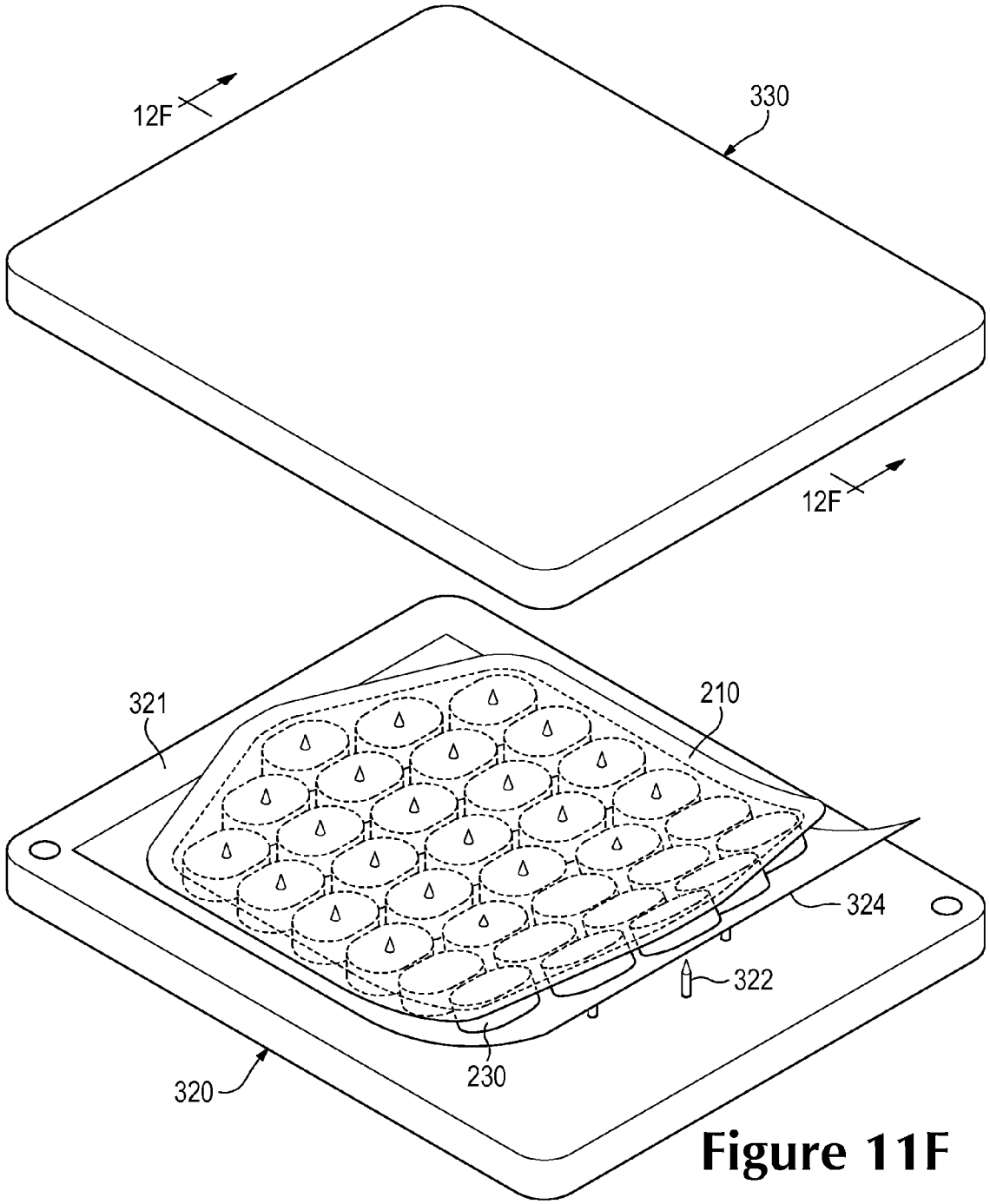

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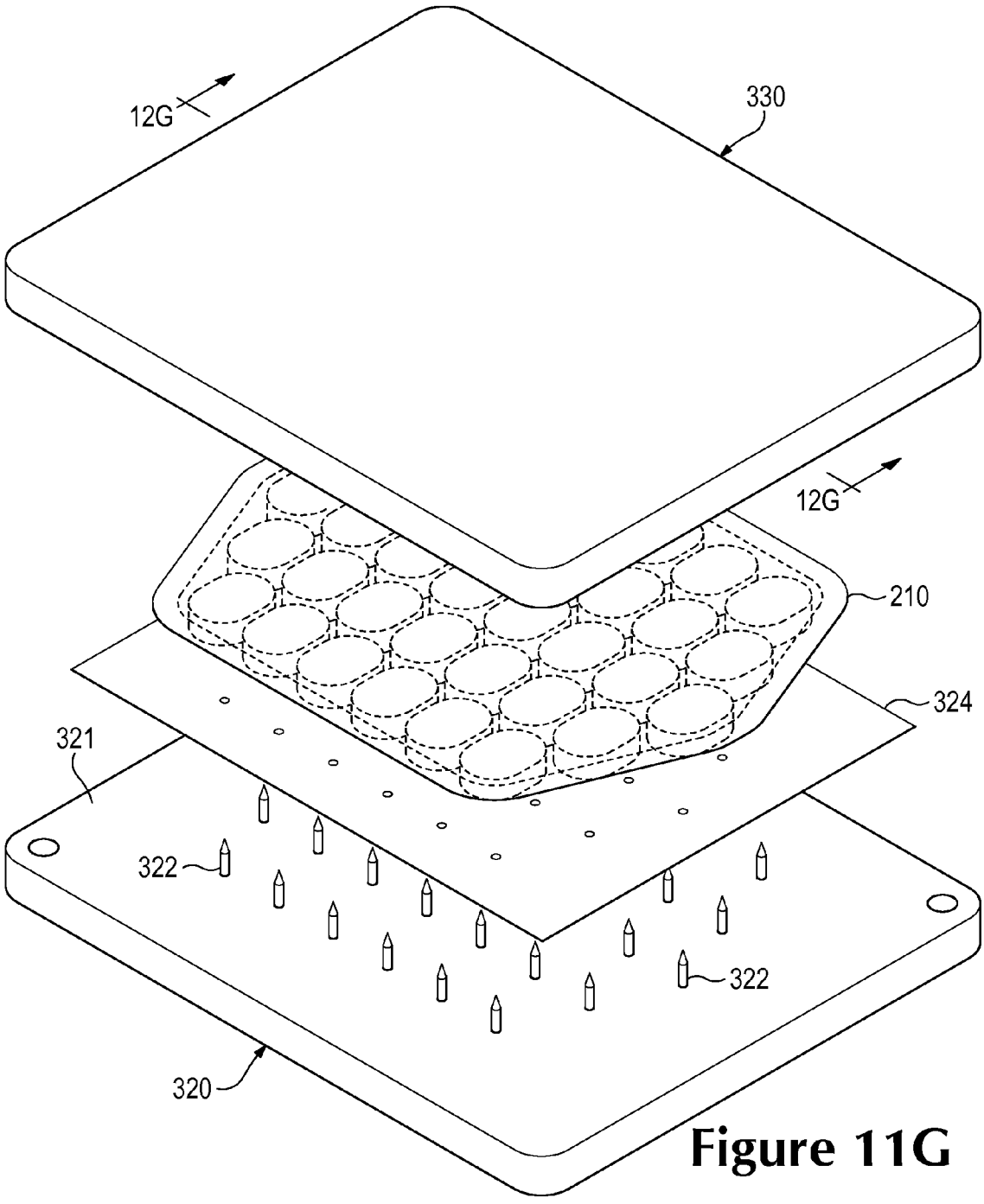
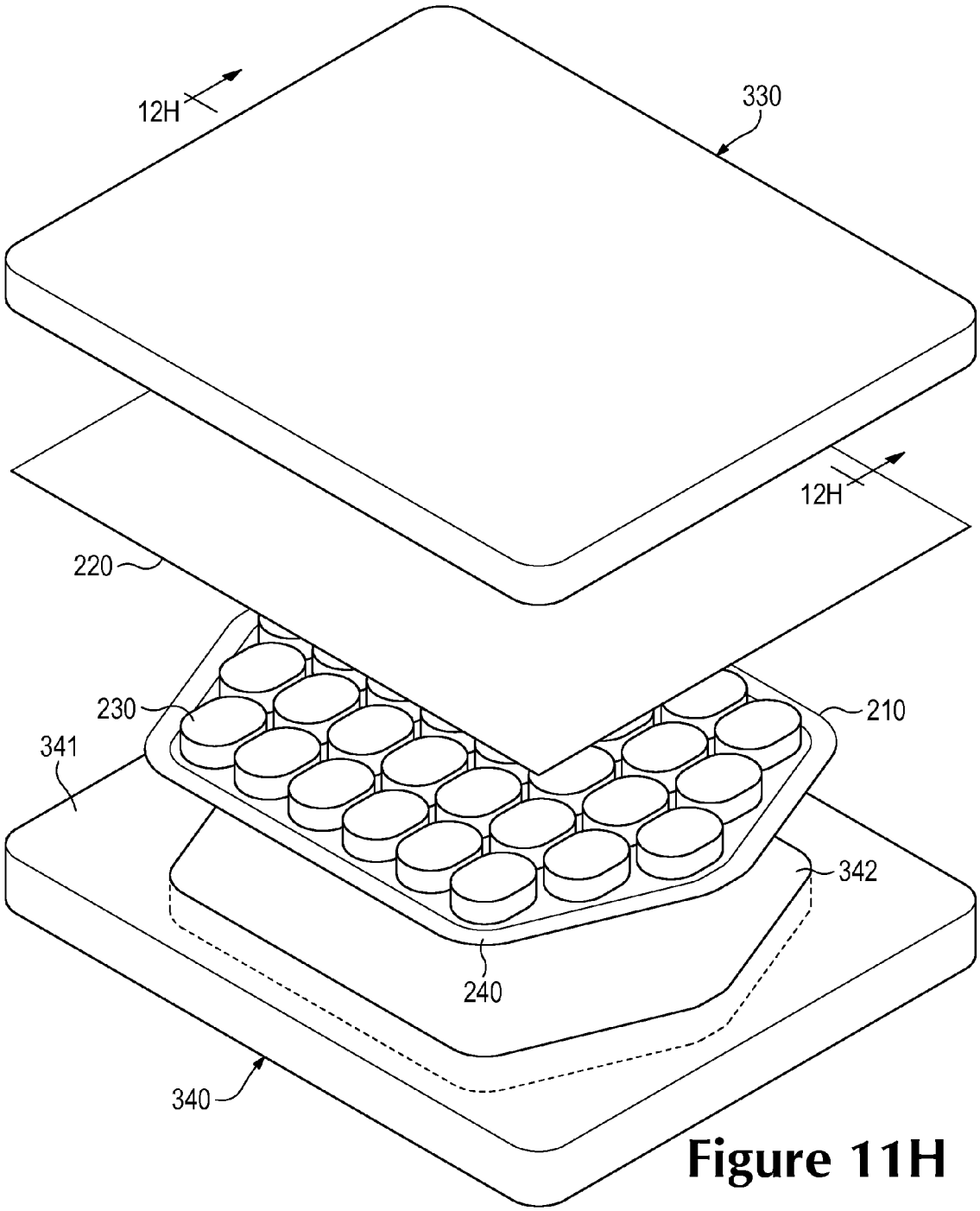


Figure 11G



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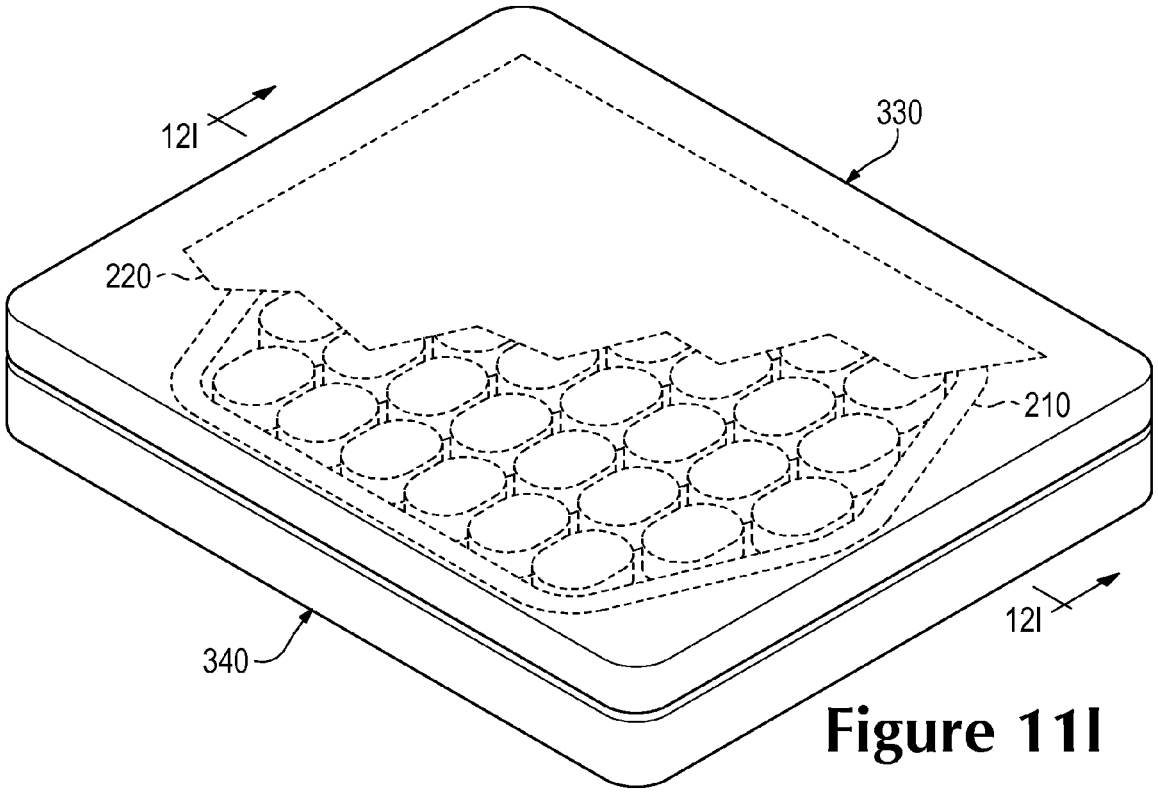
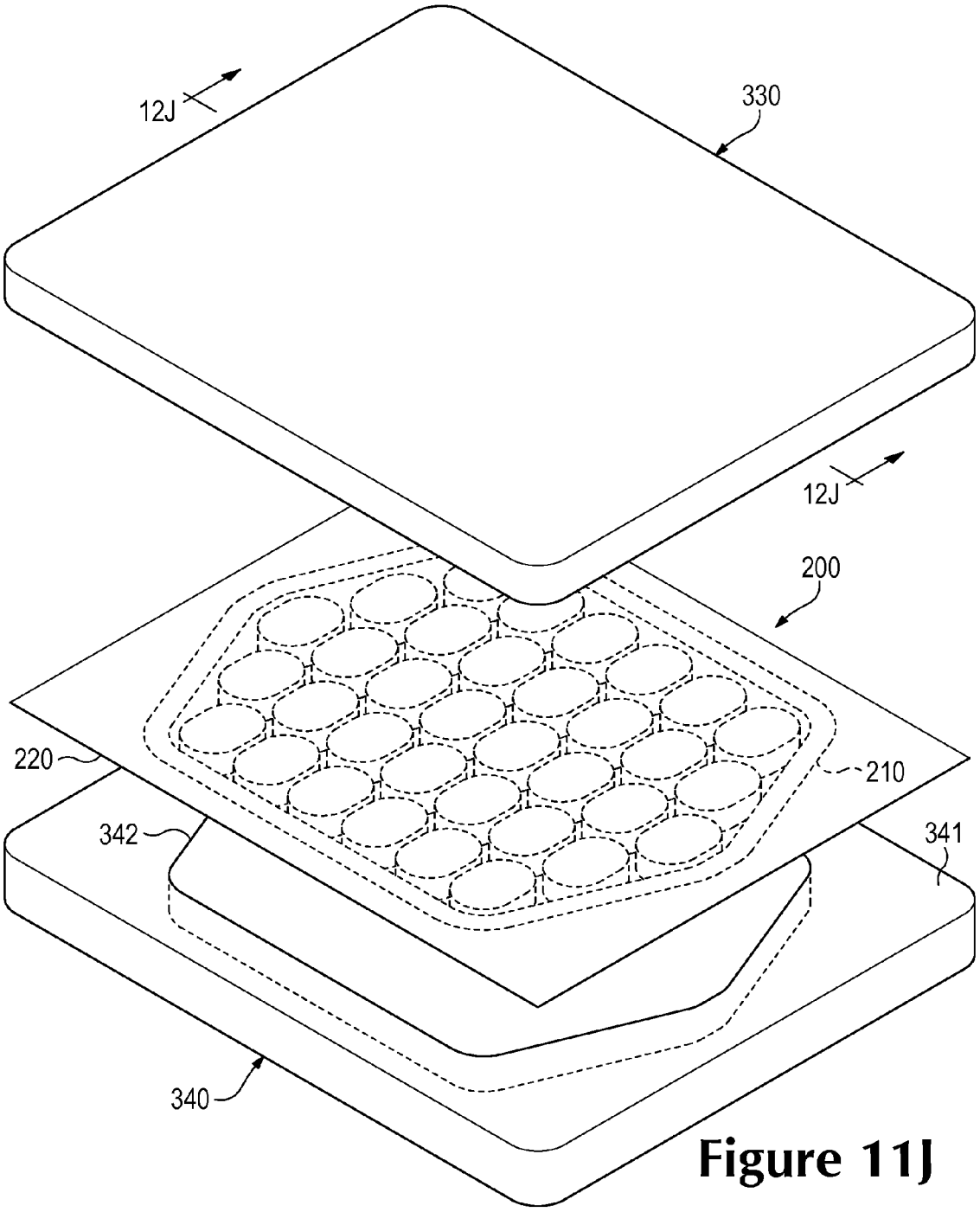


Figure 11I



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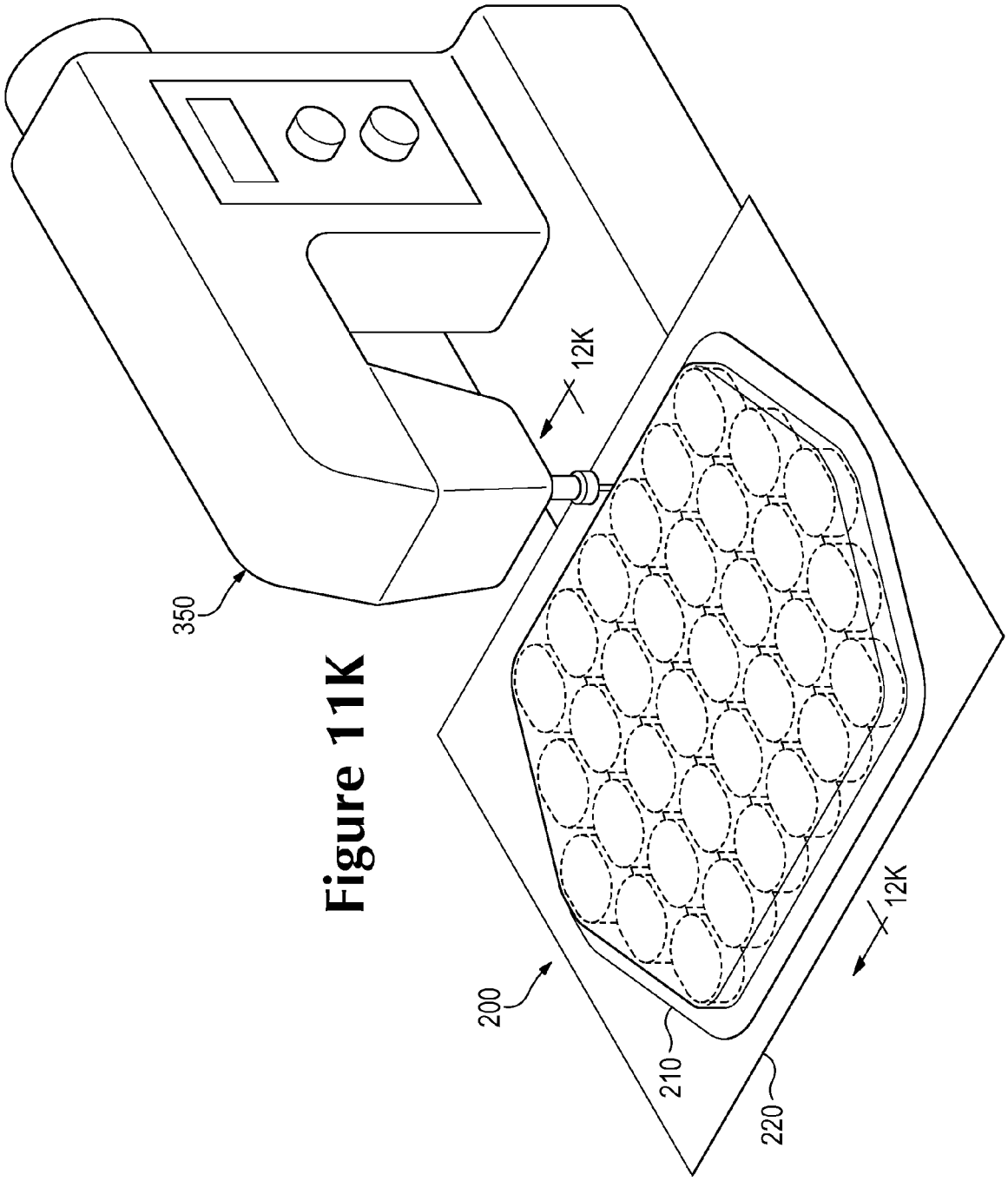

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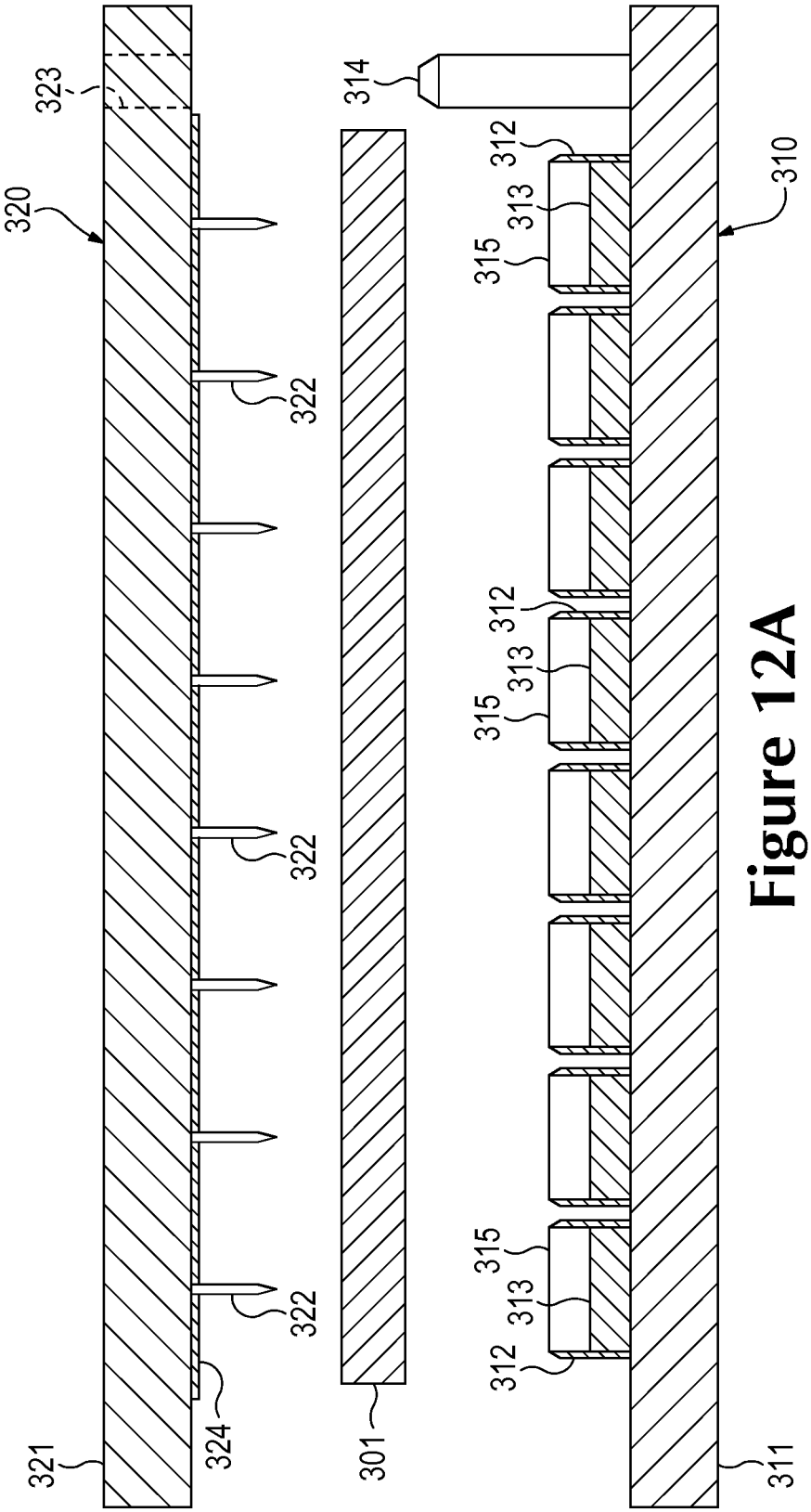
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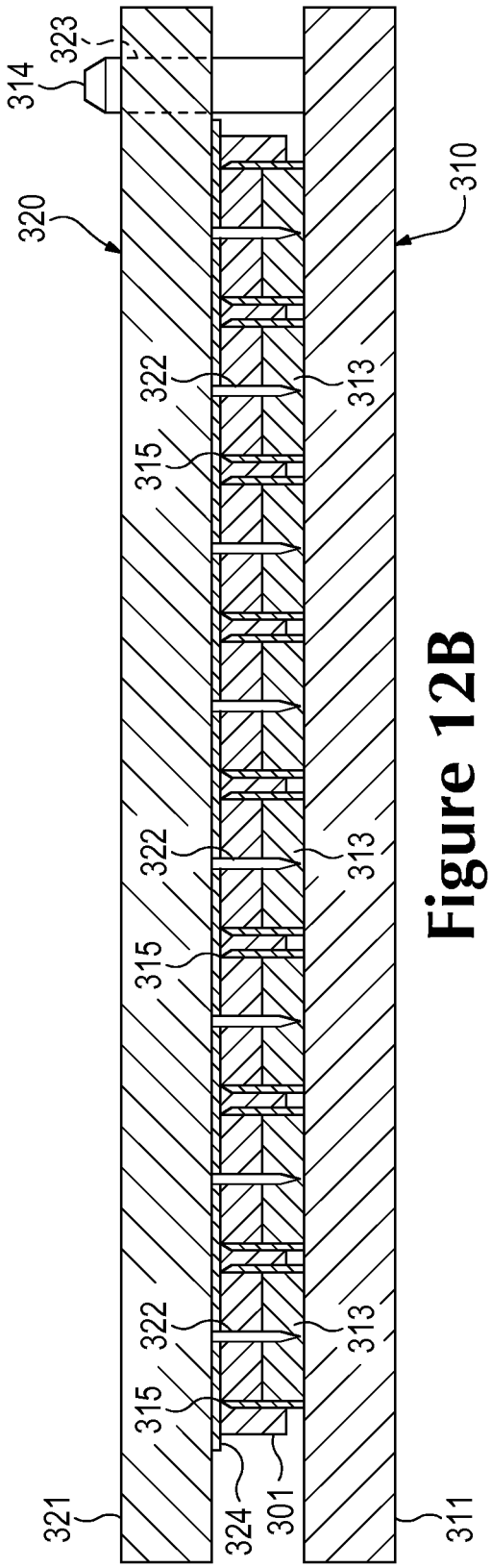
Figure 12A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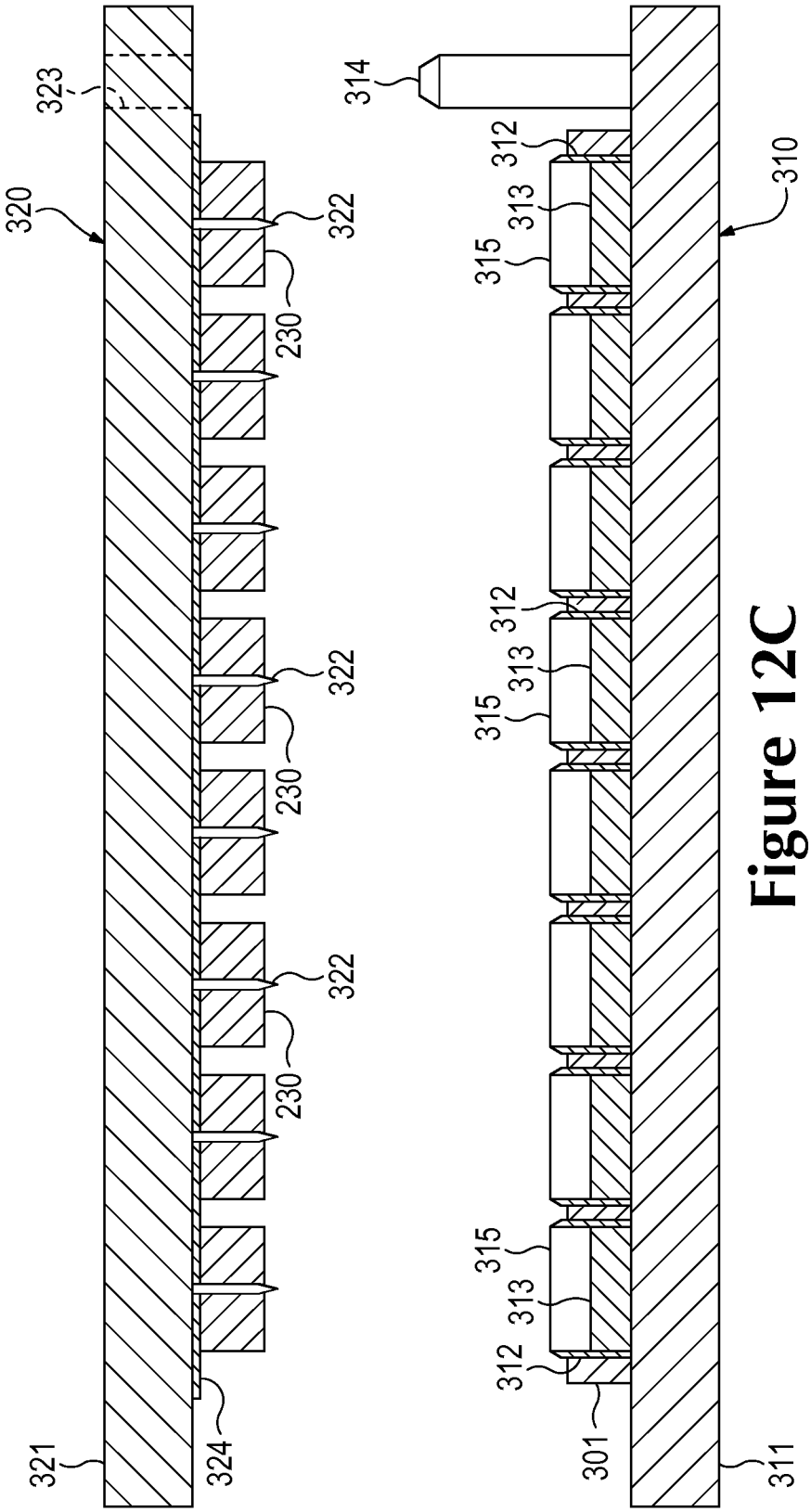
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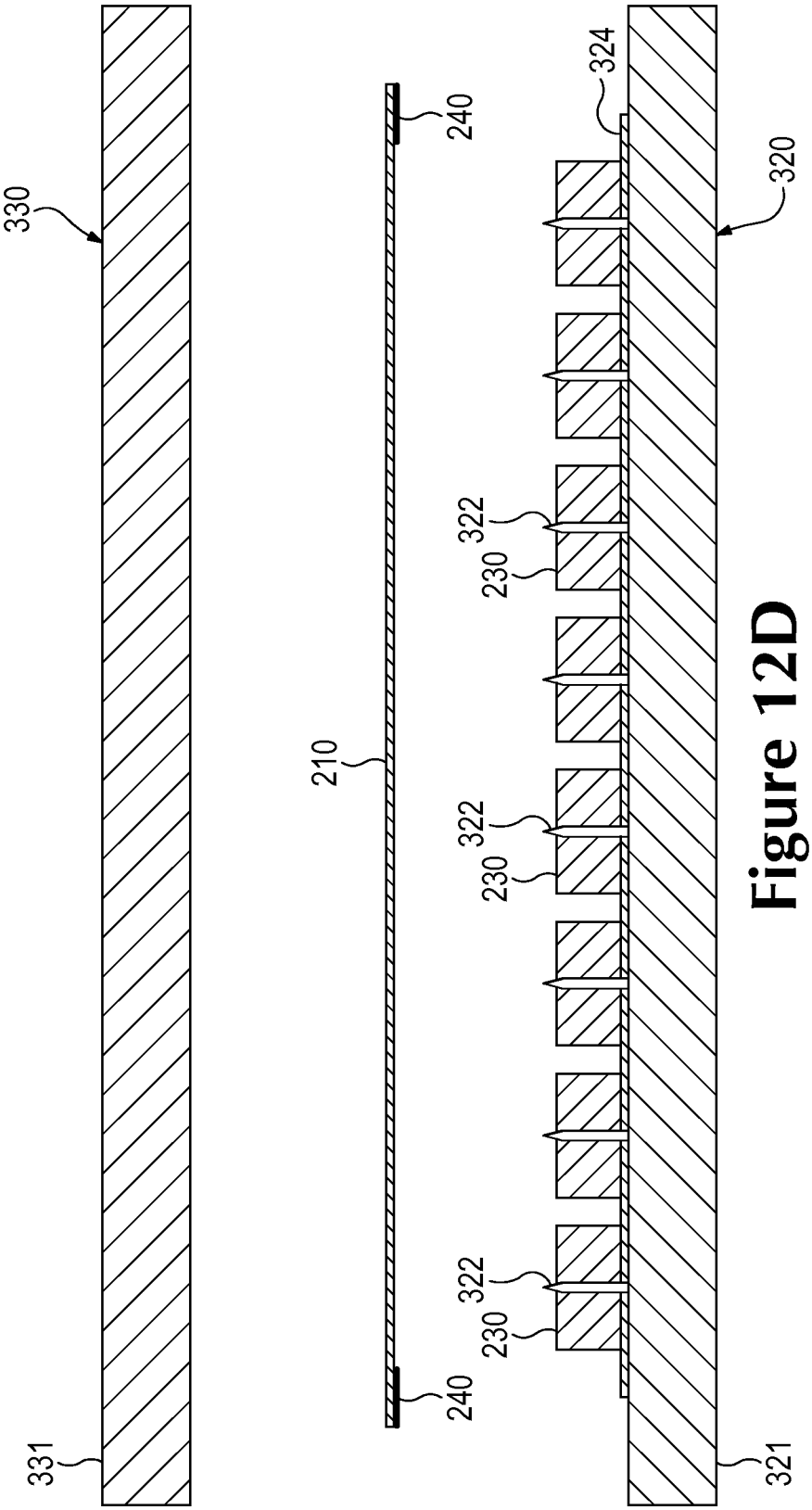

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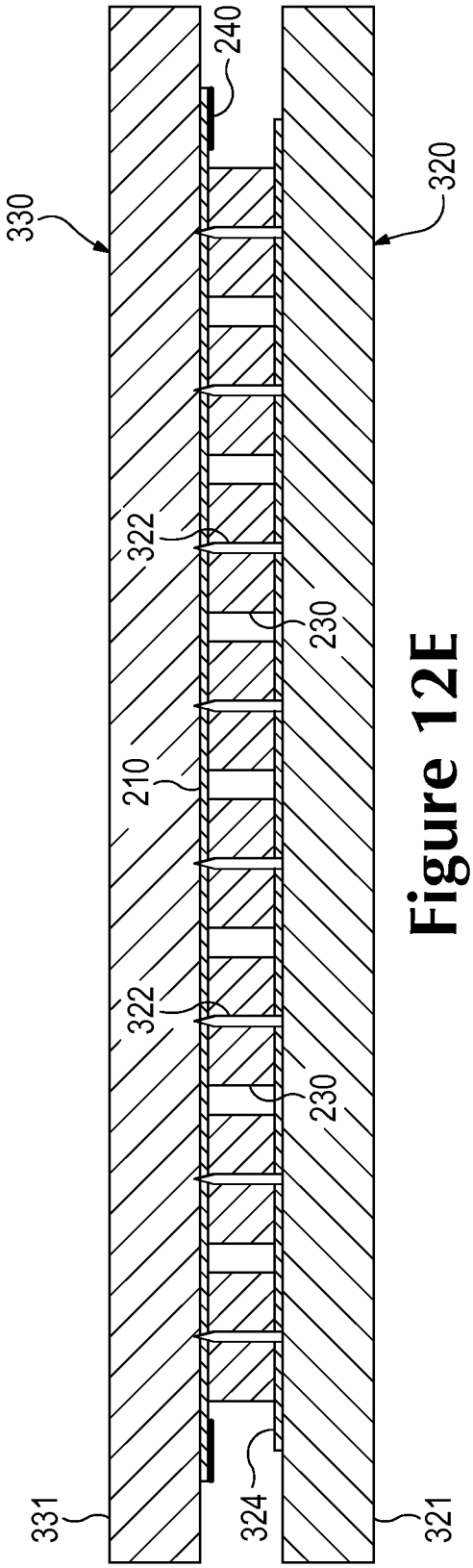

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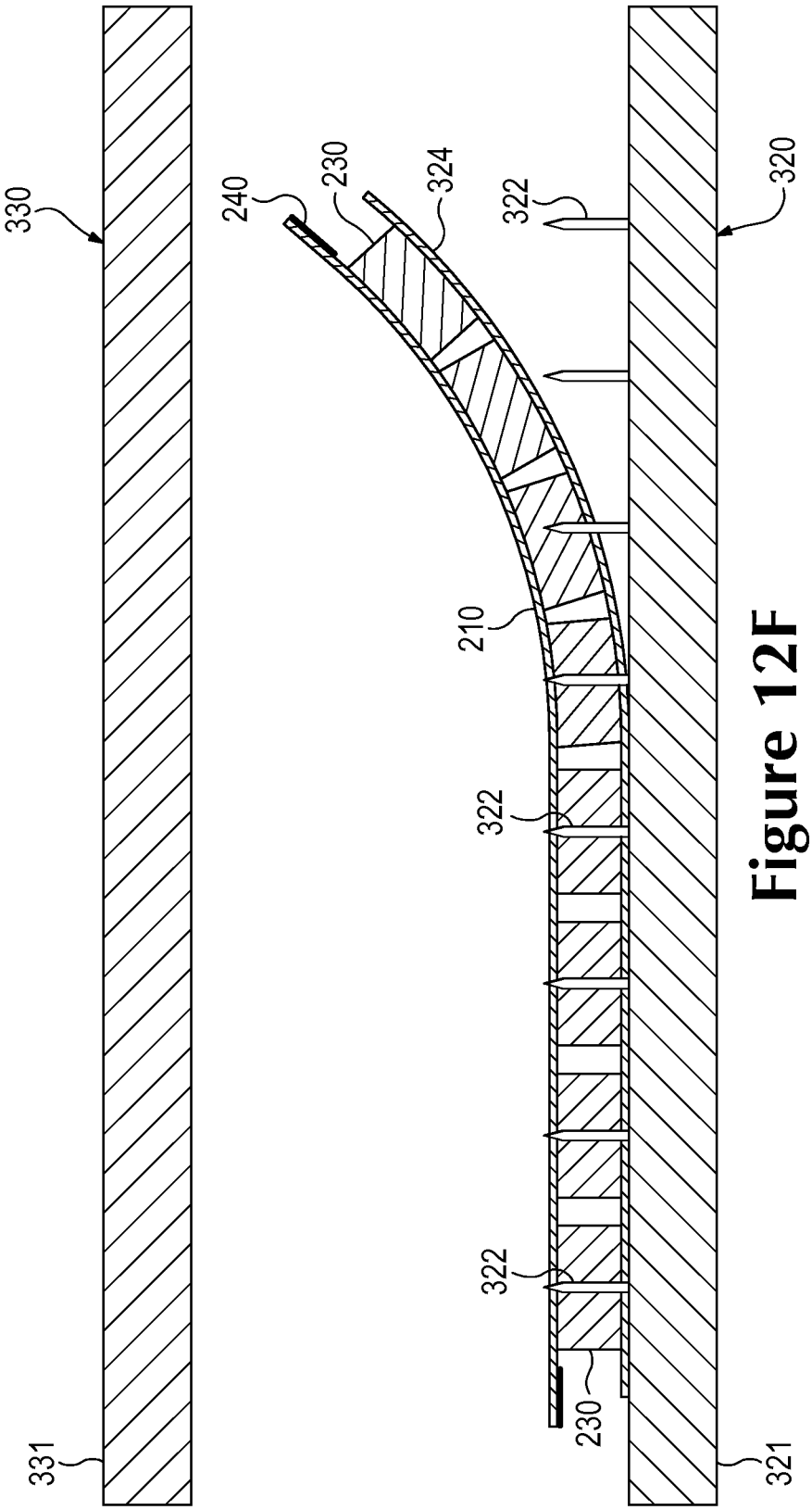

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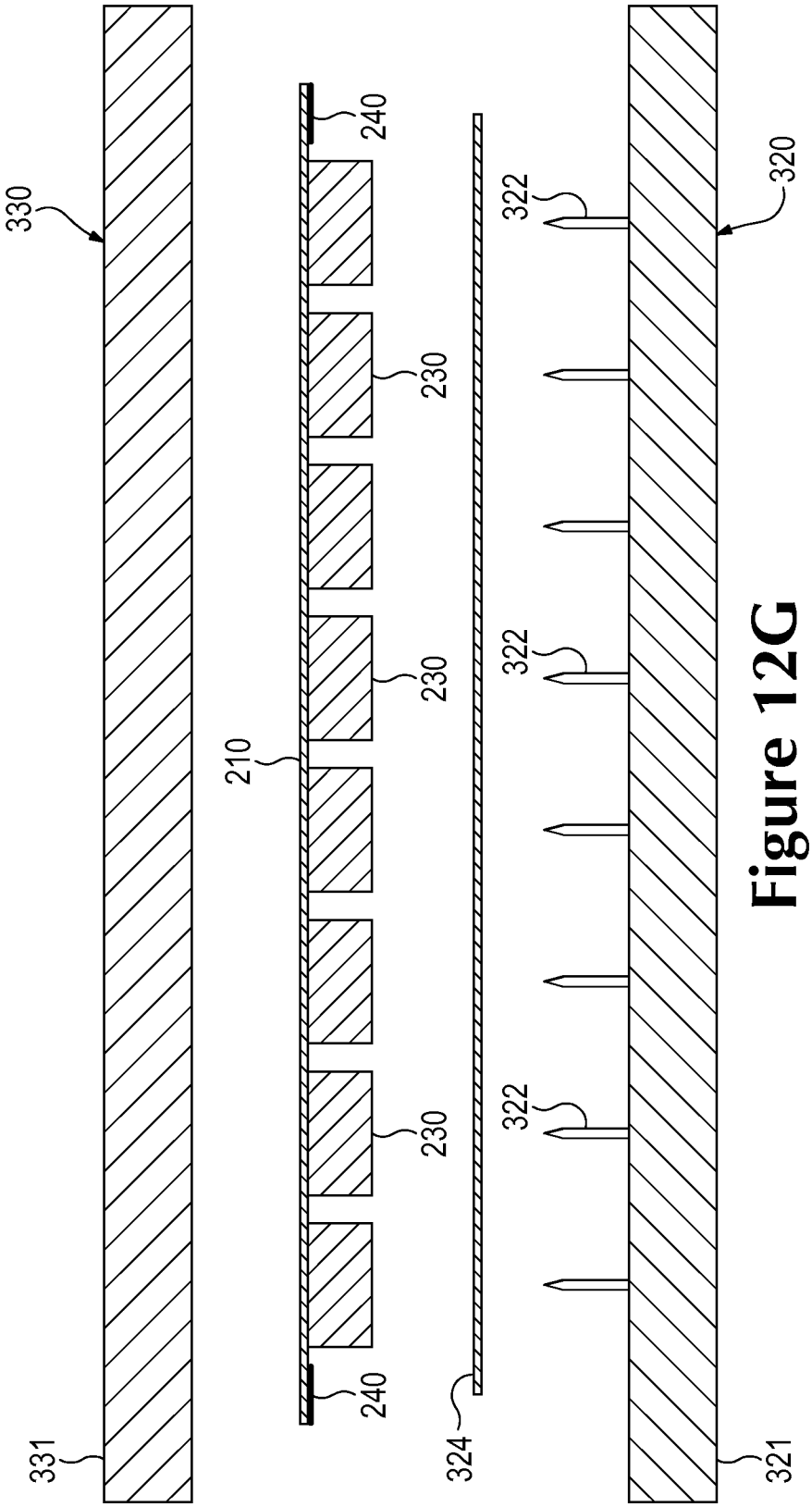

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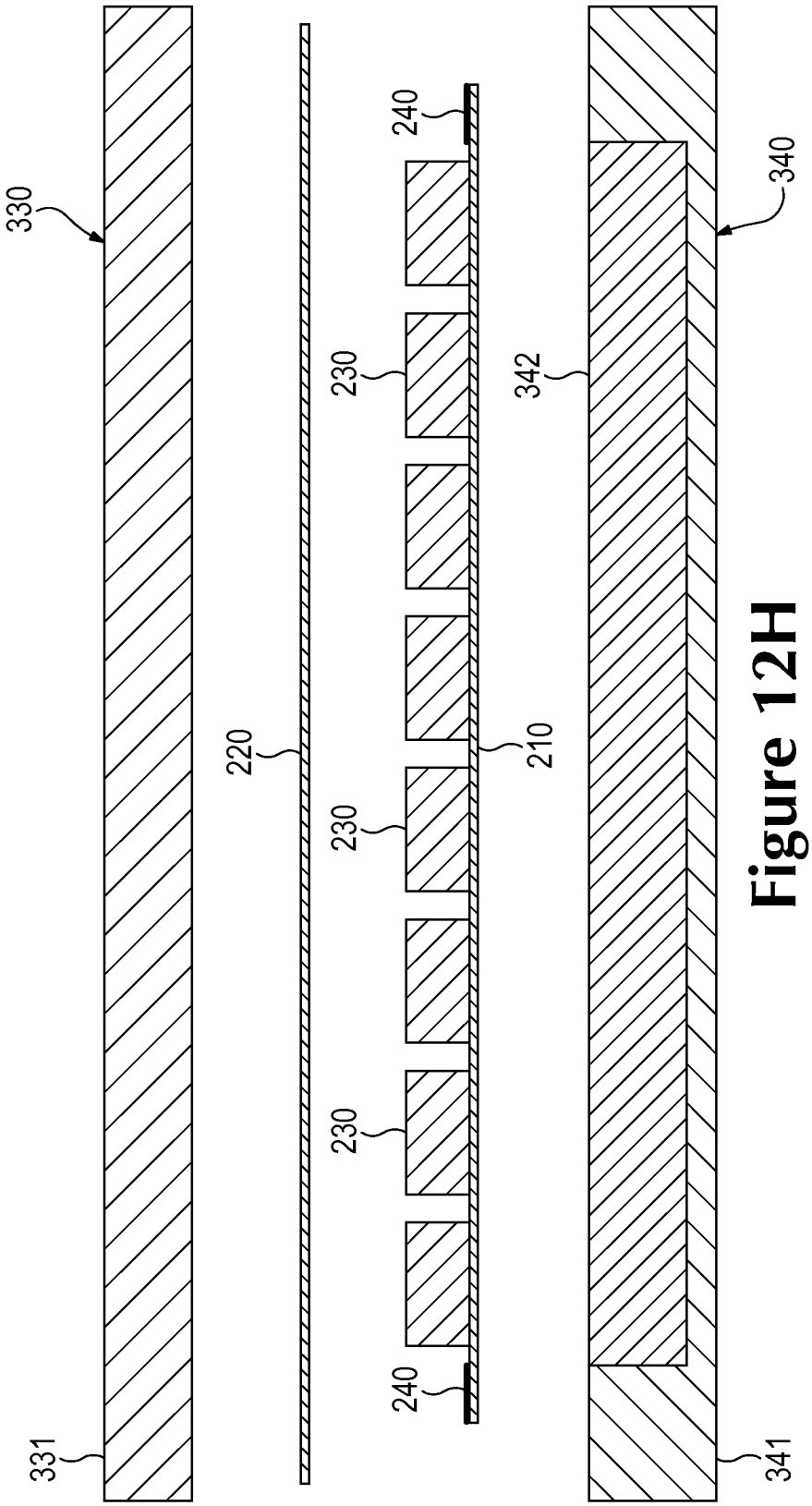

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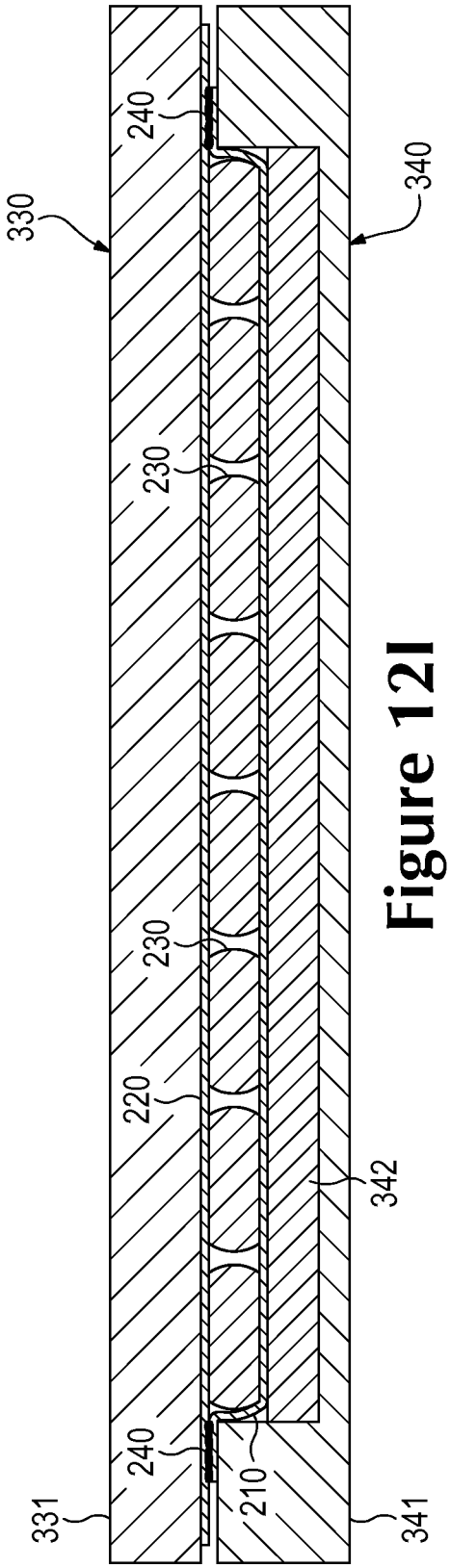

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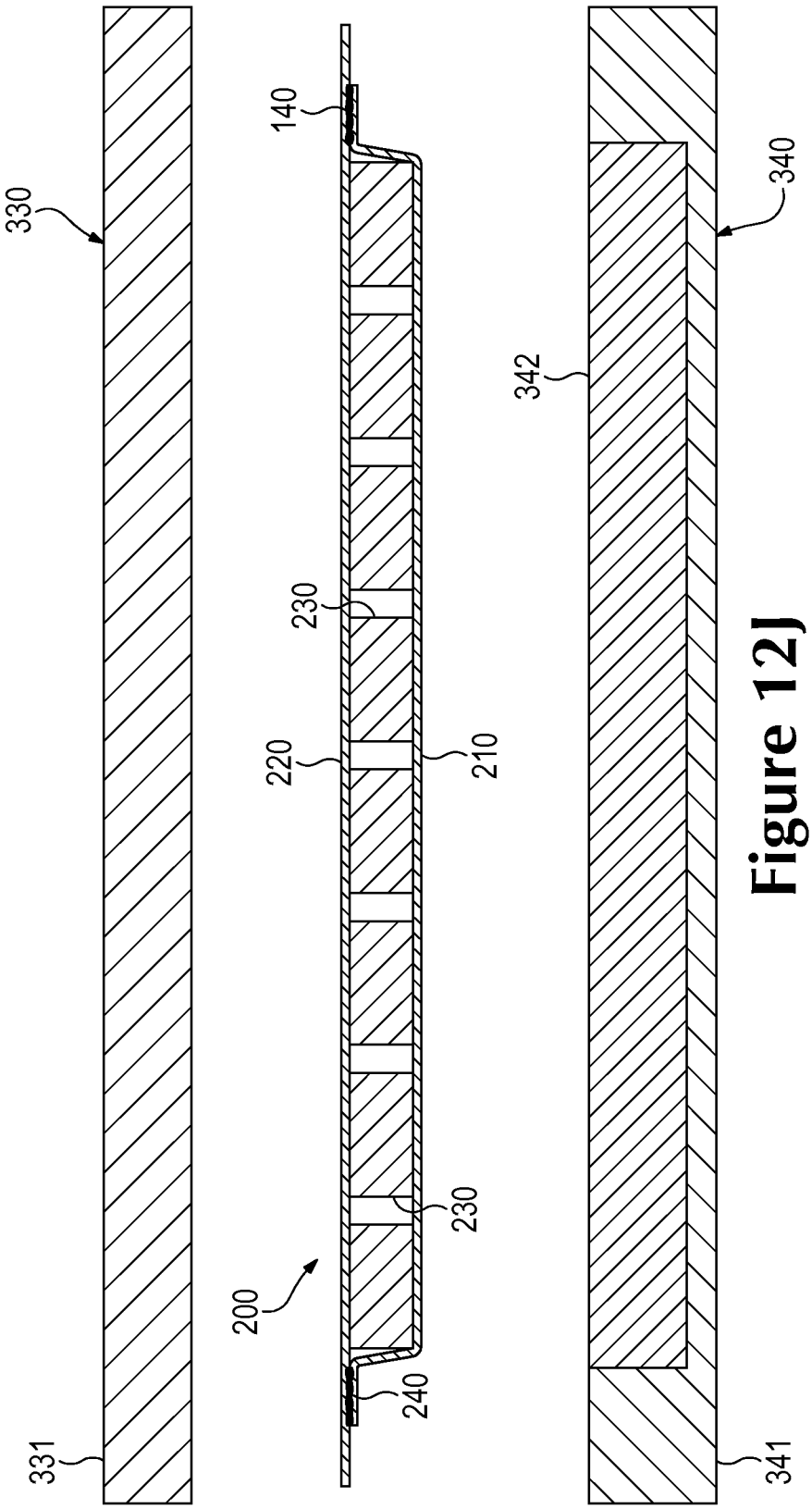

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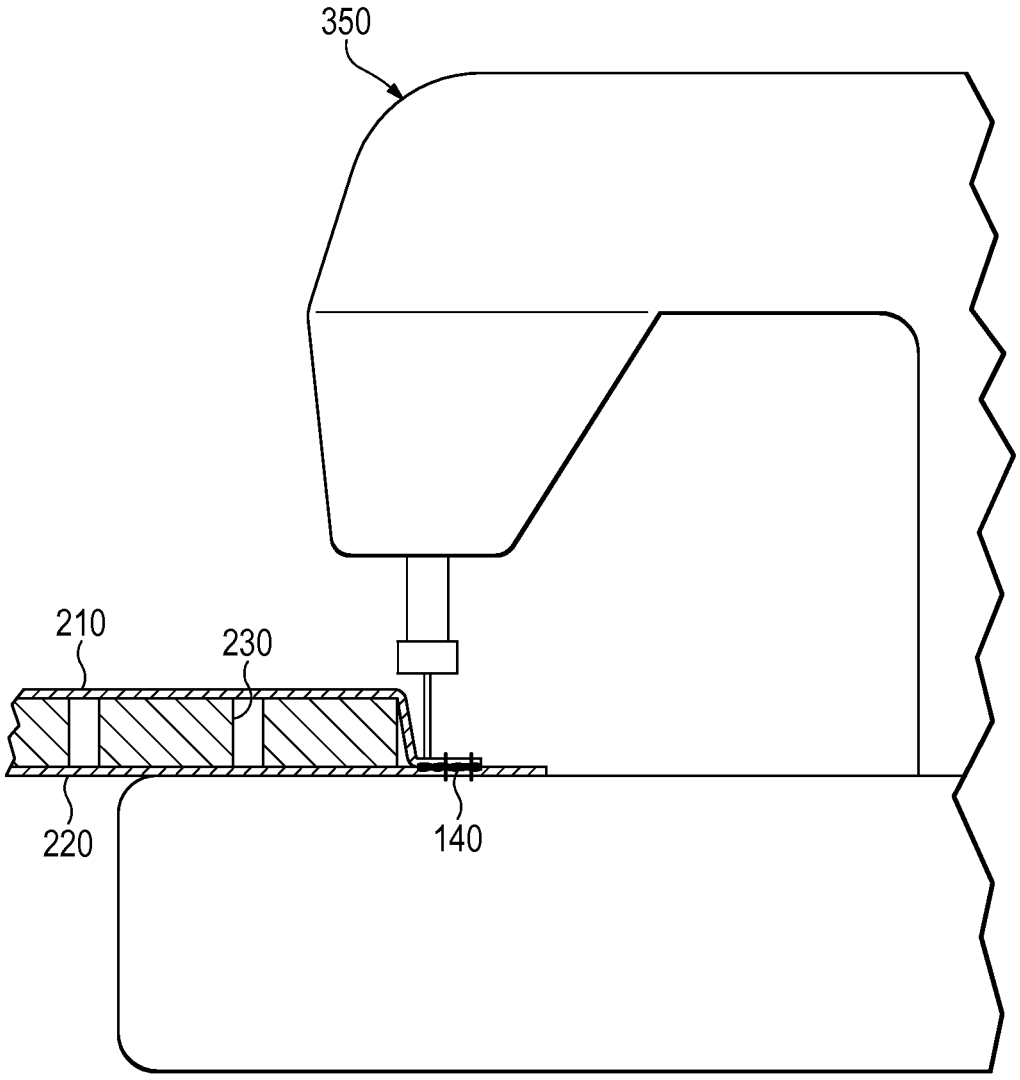

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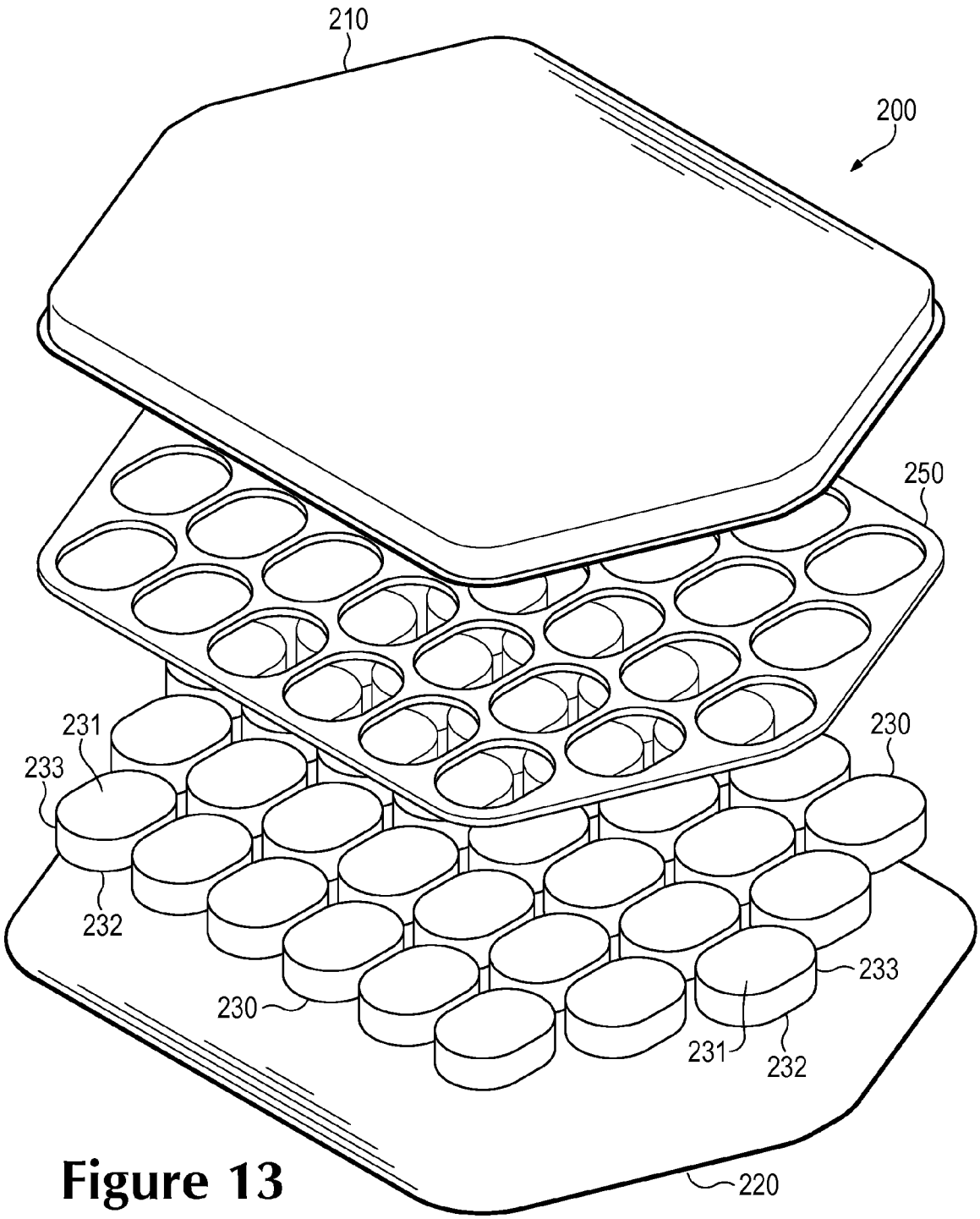

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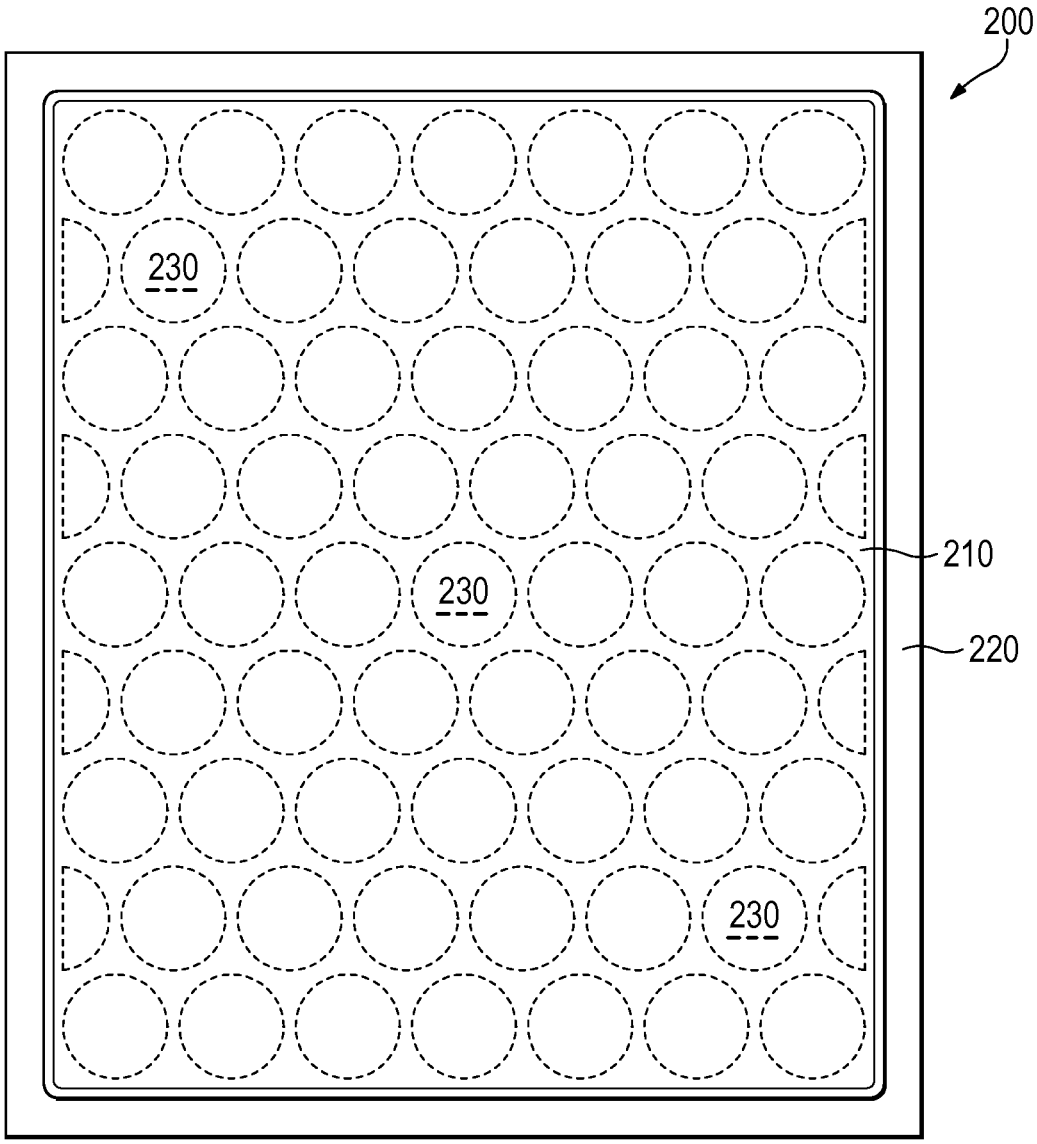

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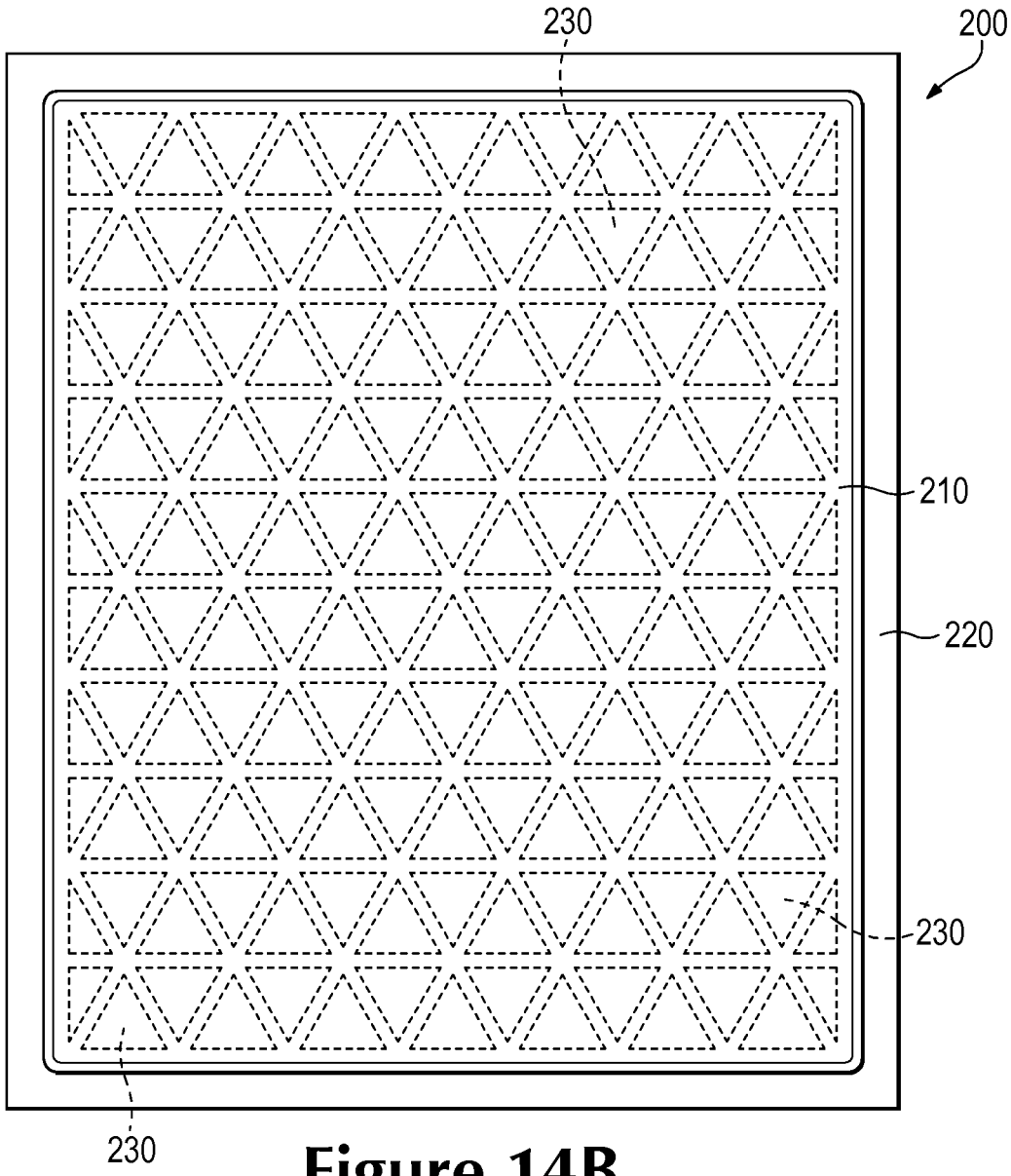

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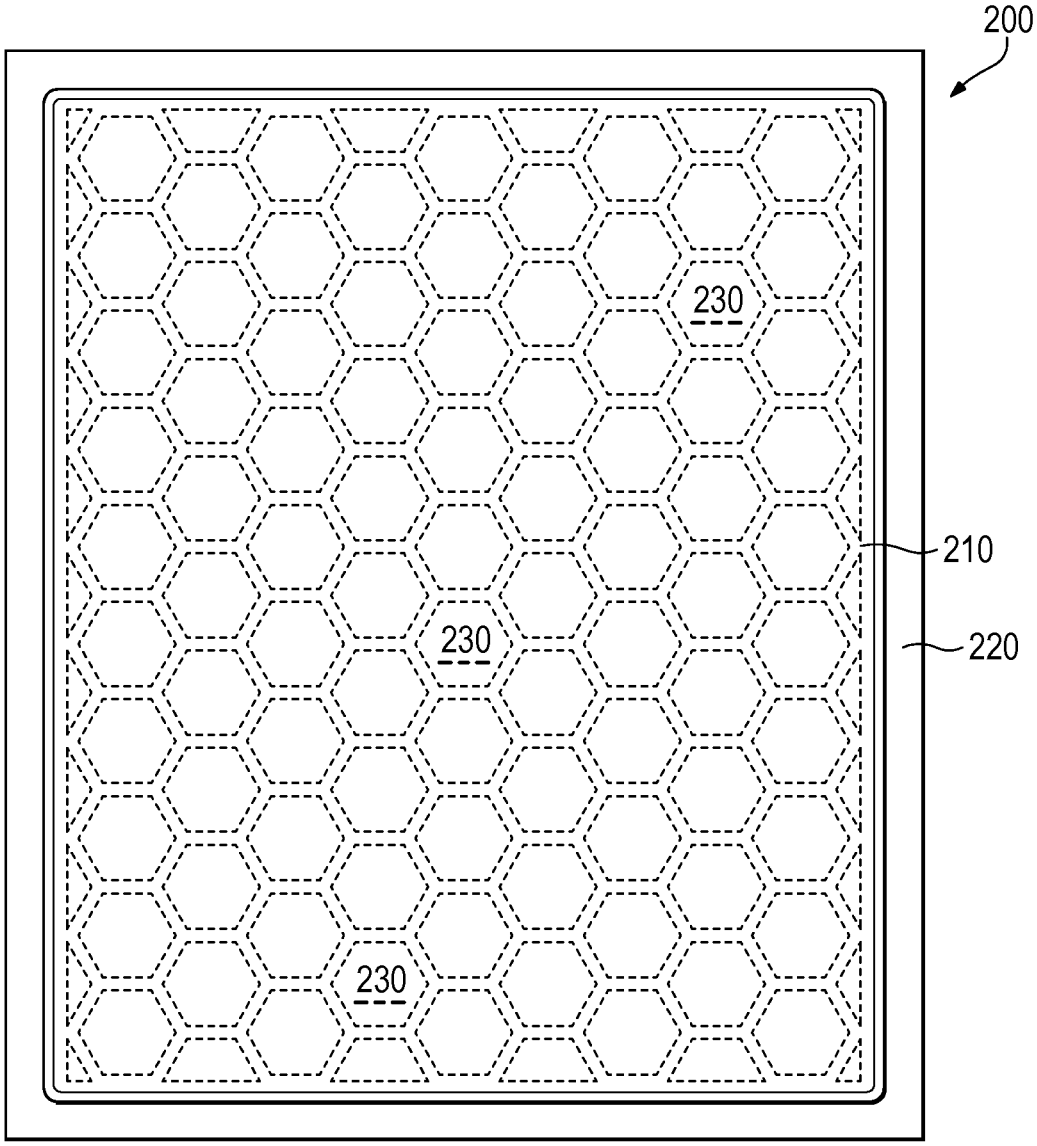

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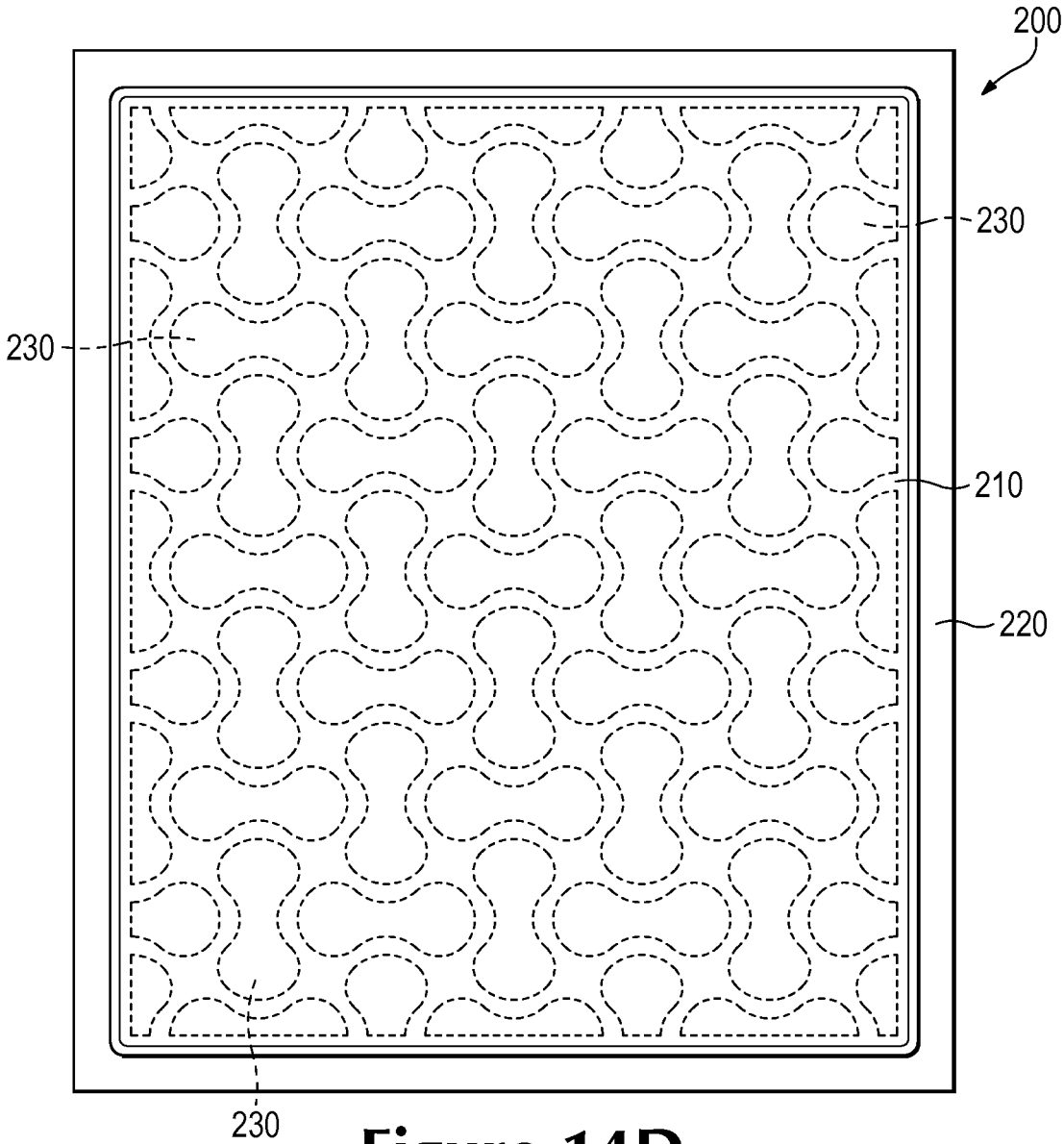

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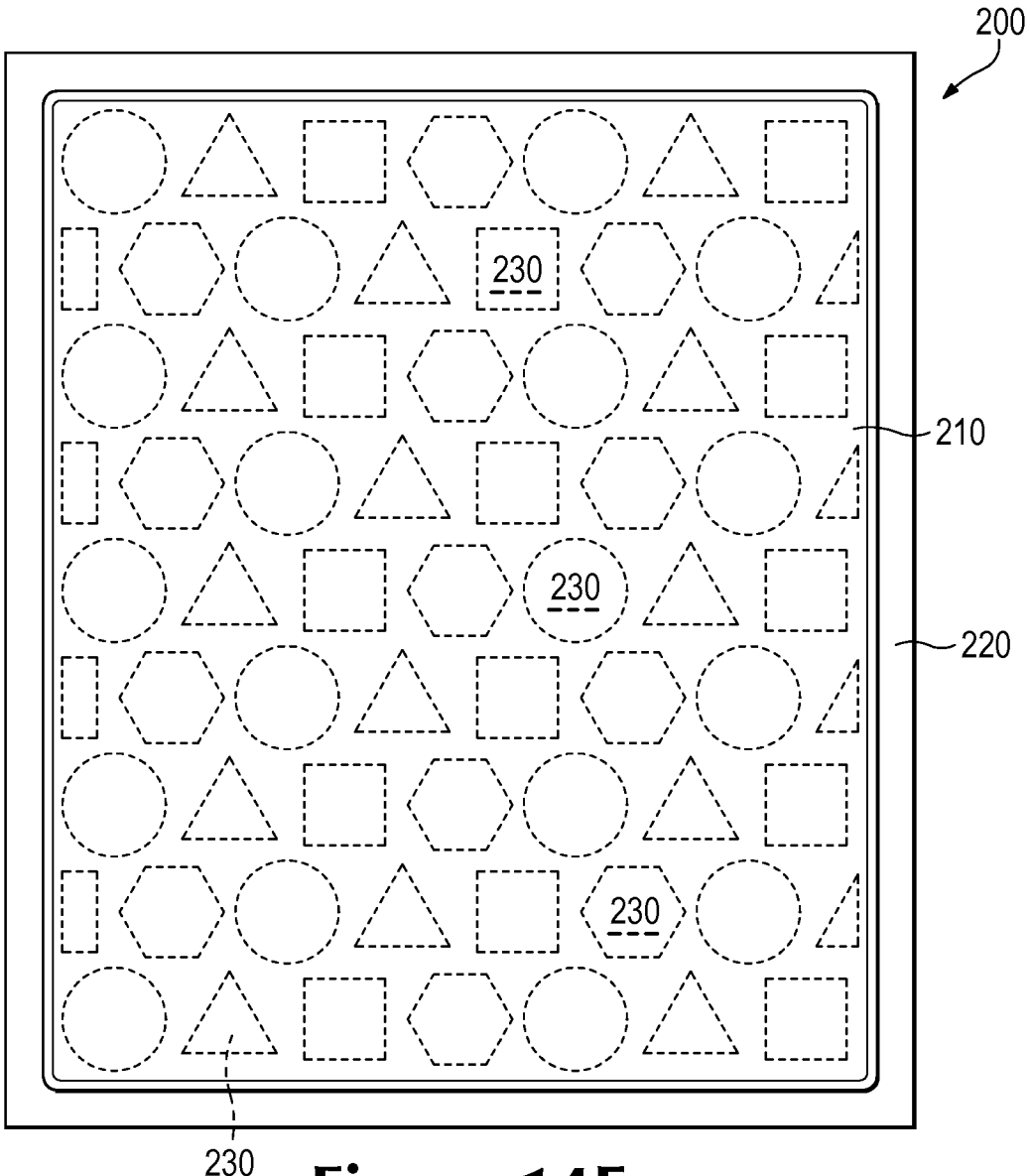

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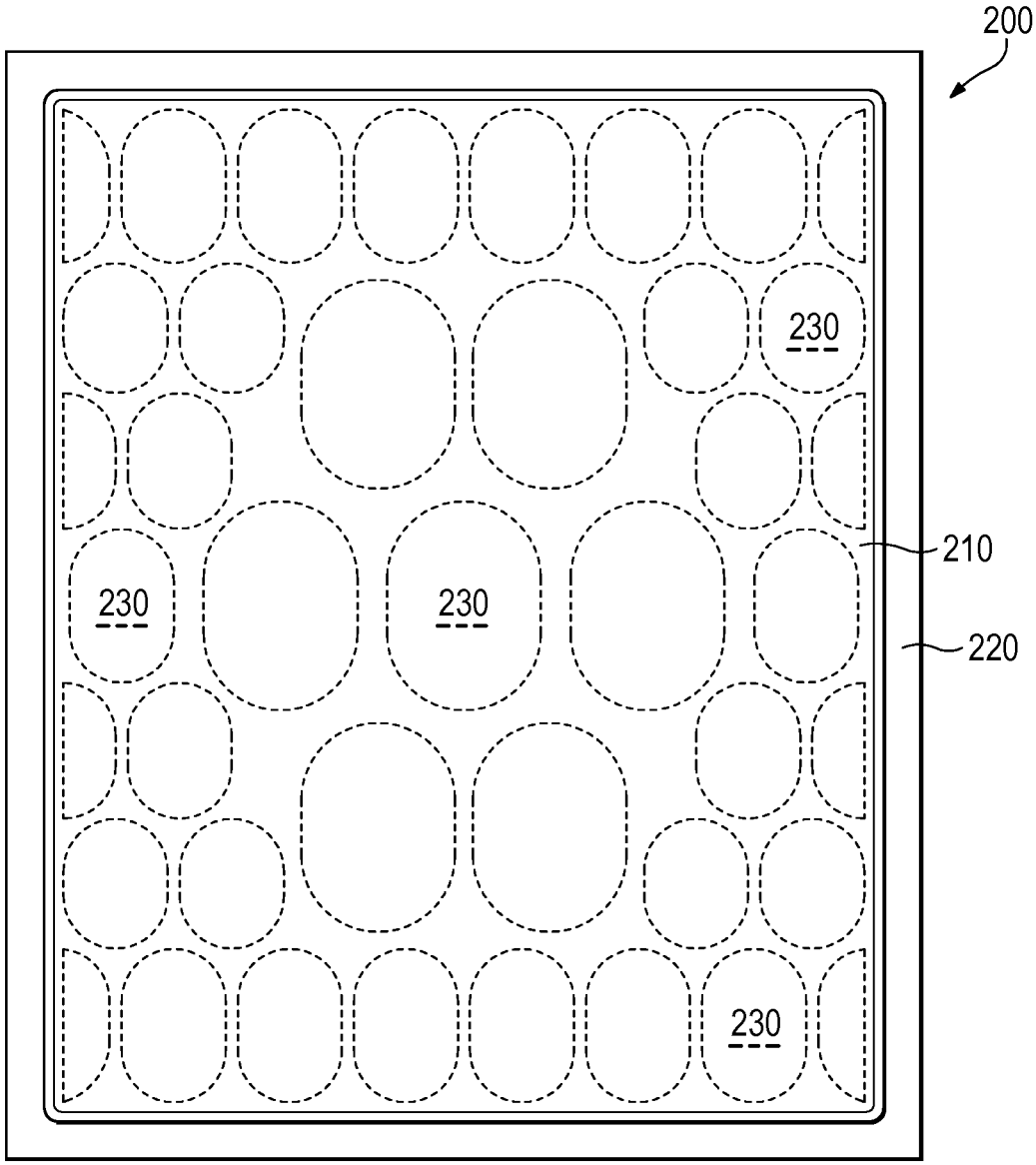

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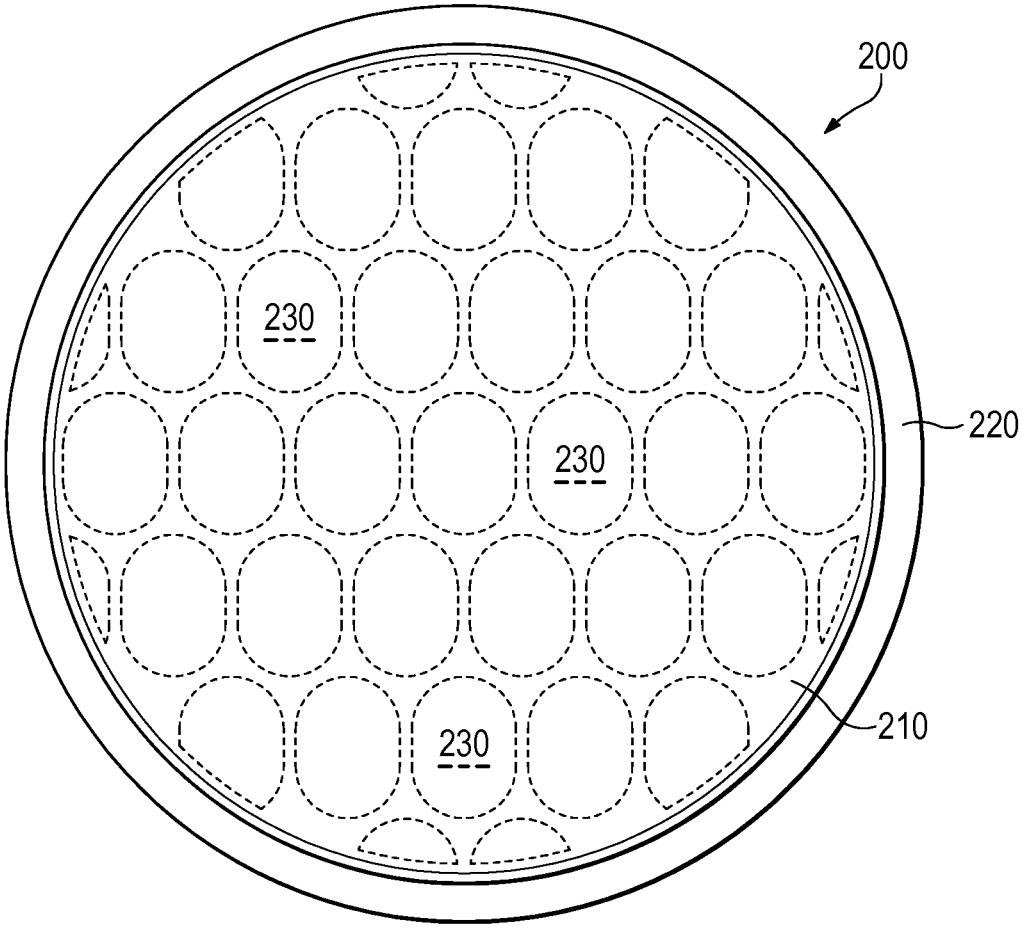


Figure 14G

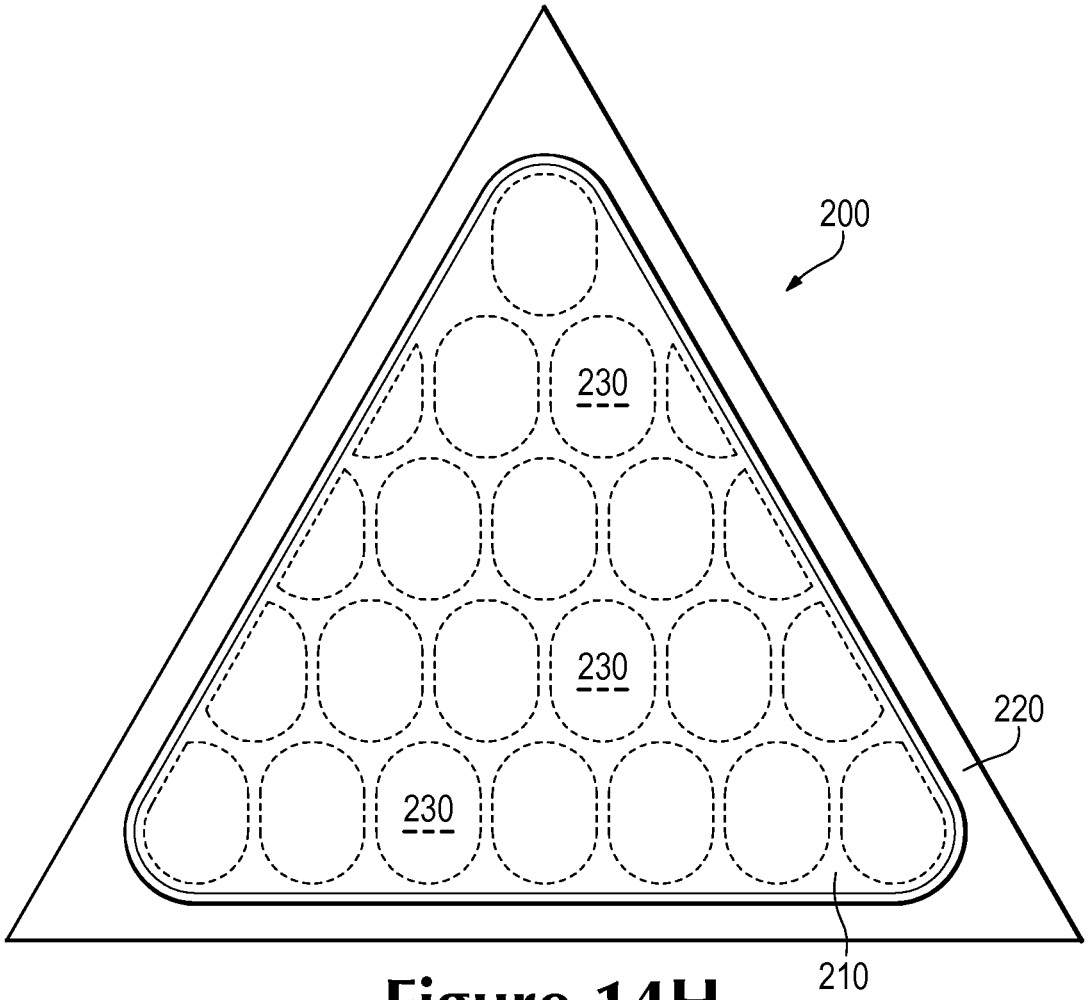


Figure 14H

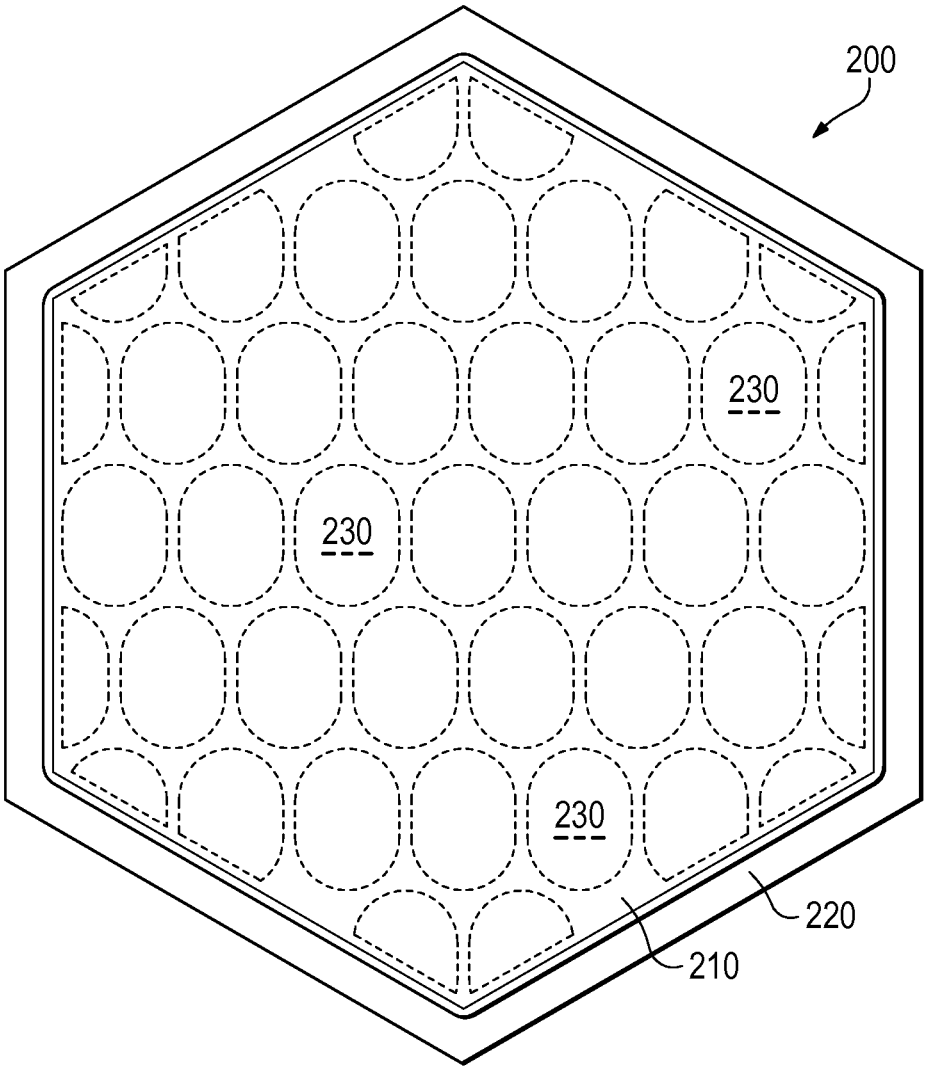


Figure 14I

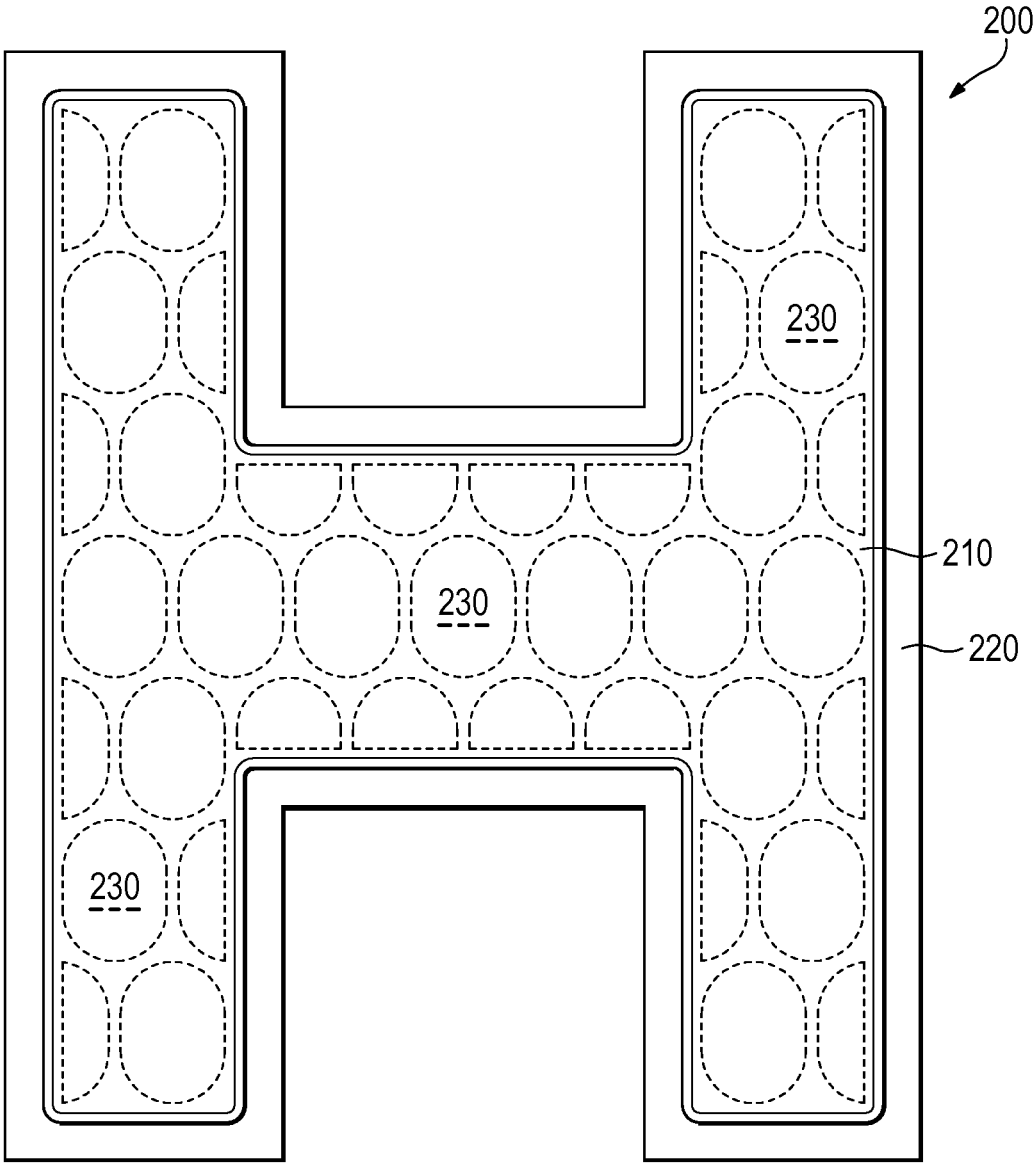


Figure 14J

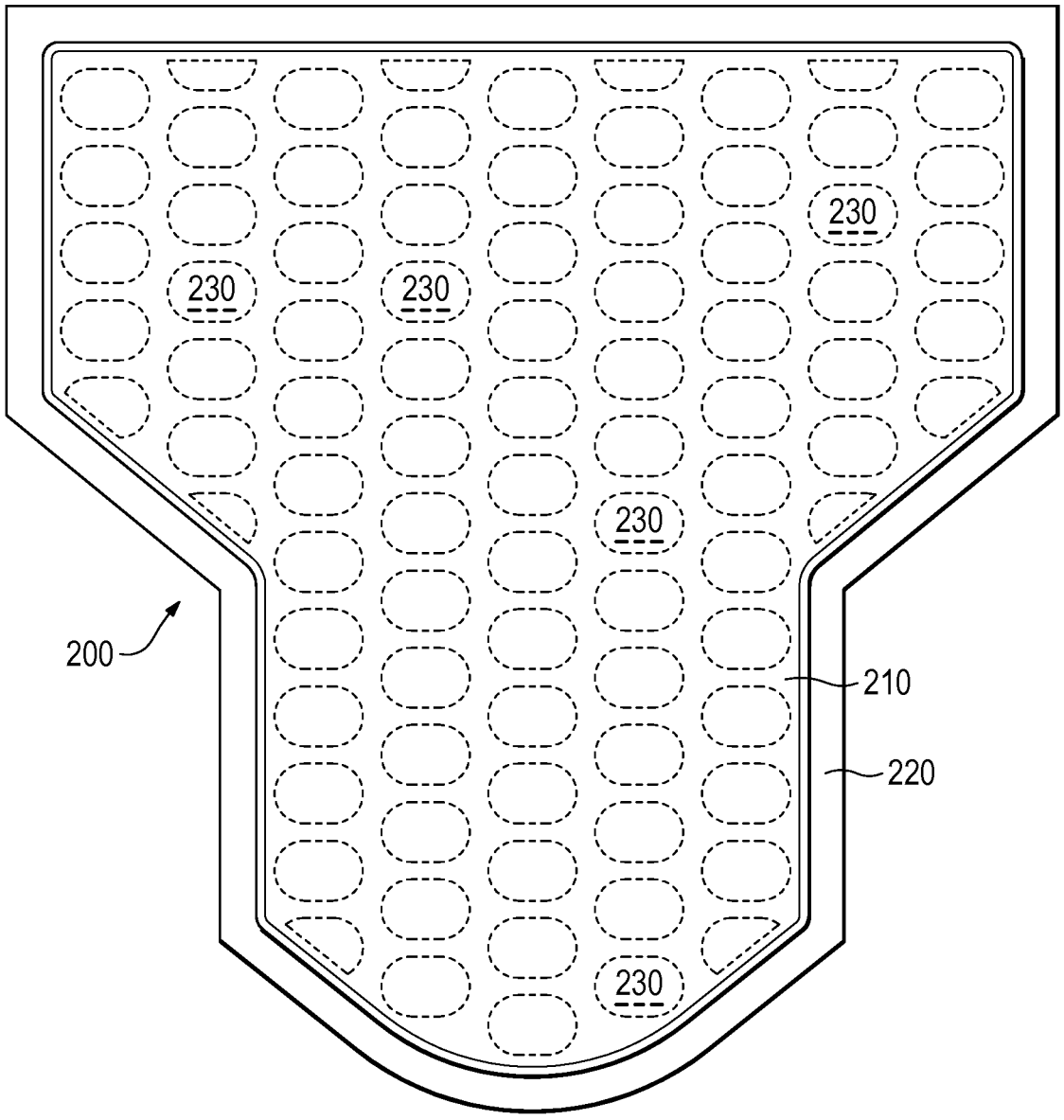


Figure 14K

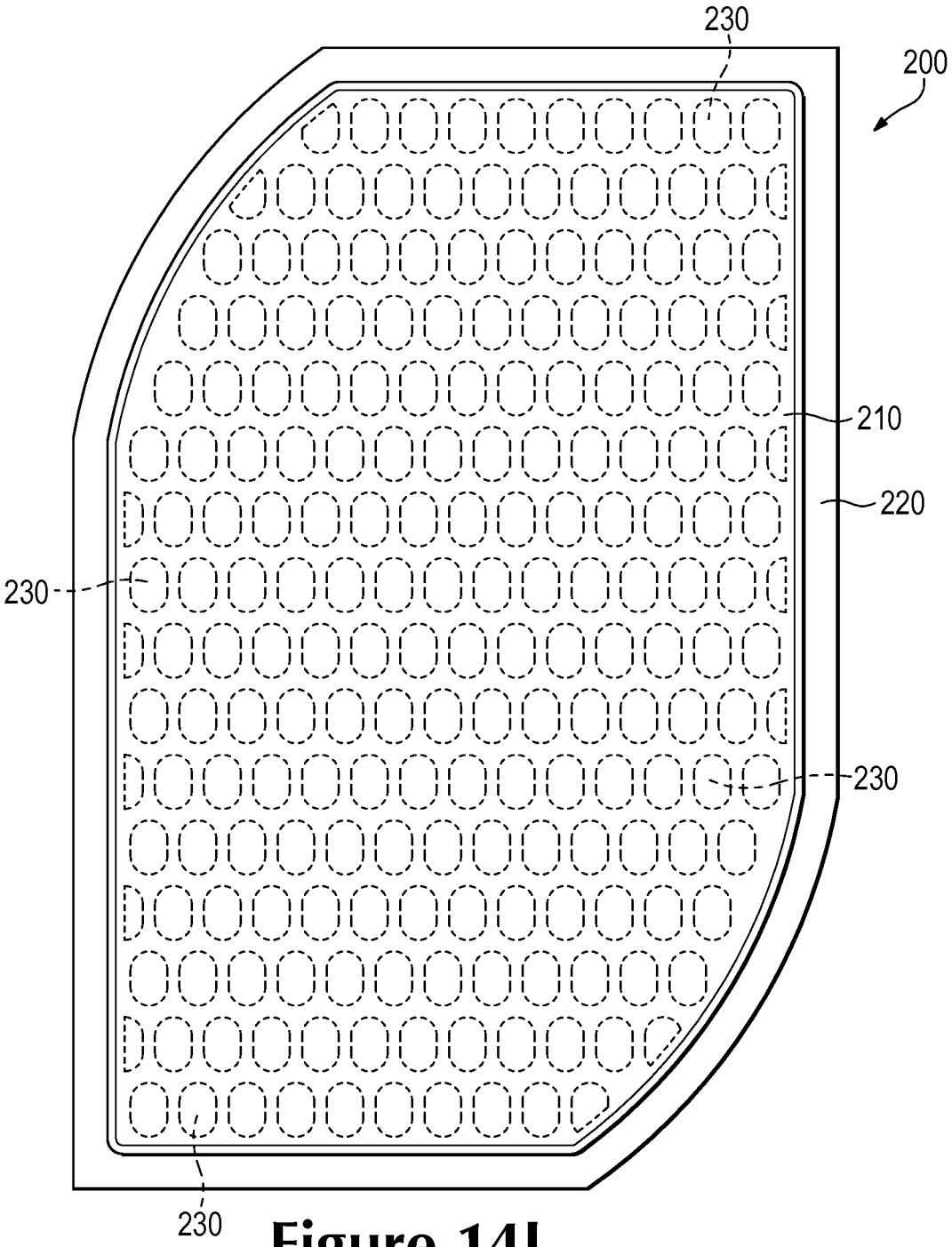
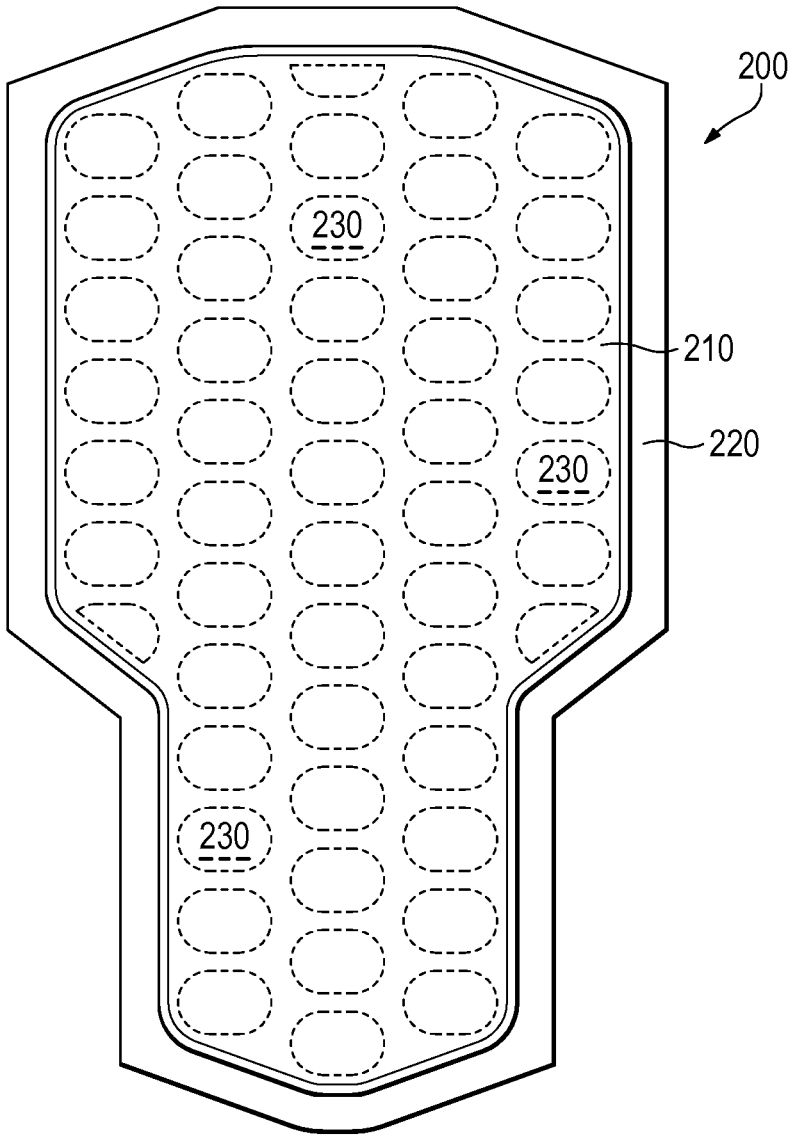


Figure 14L



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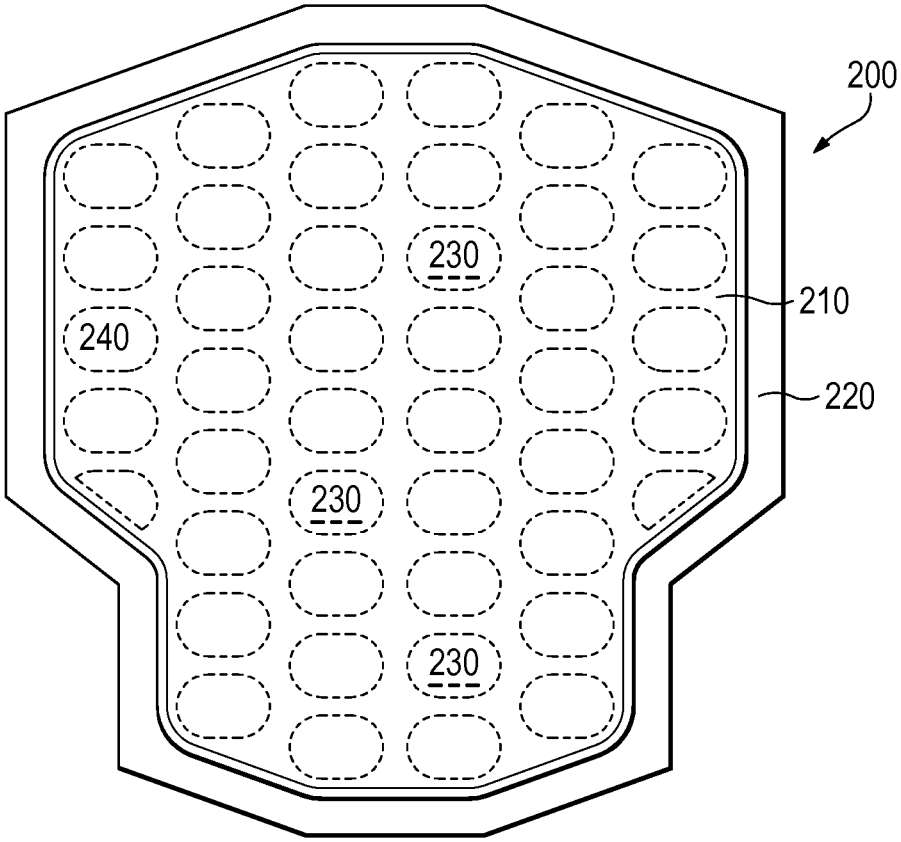

Figure 14N

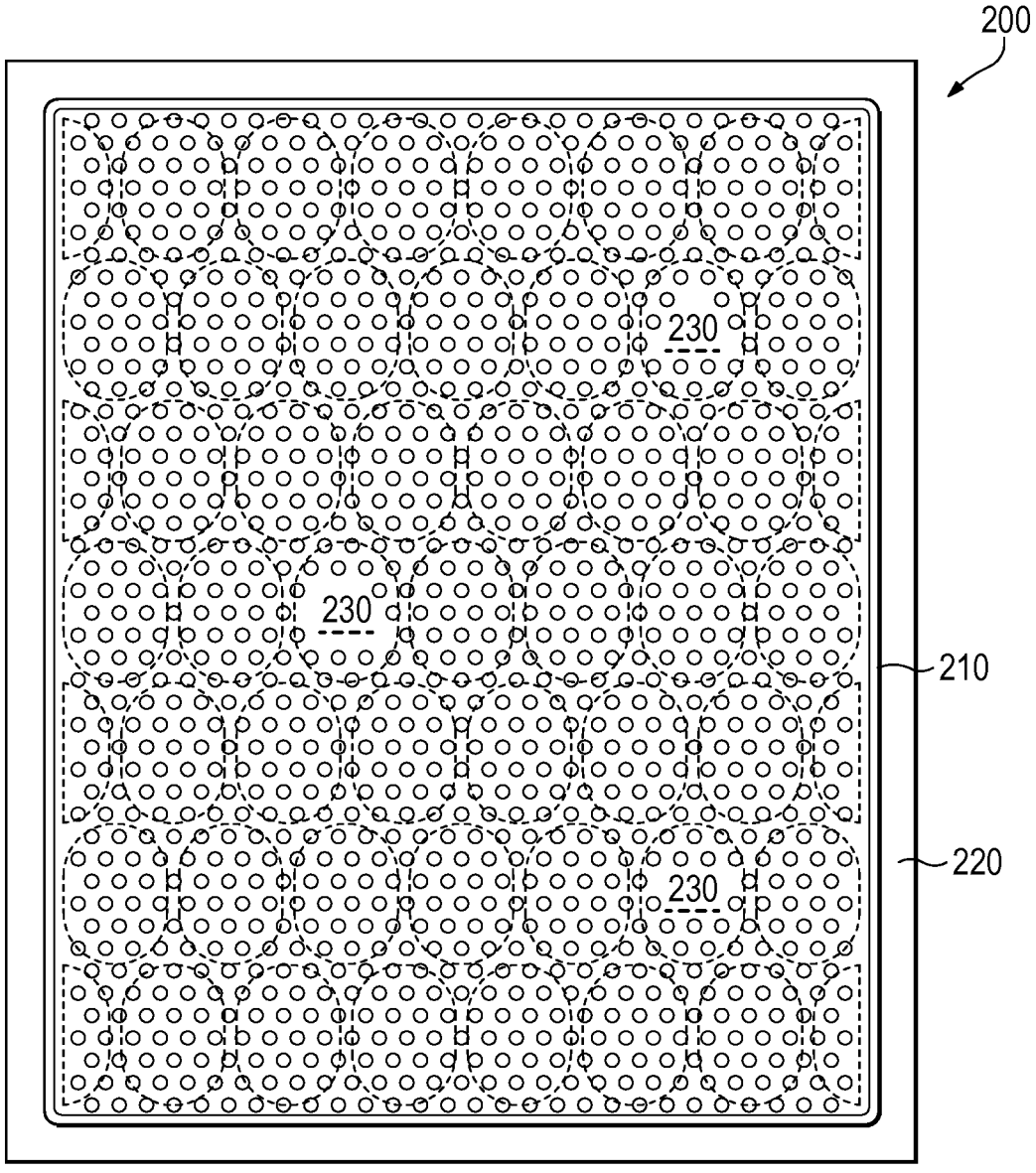

Figure 14O

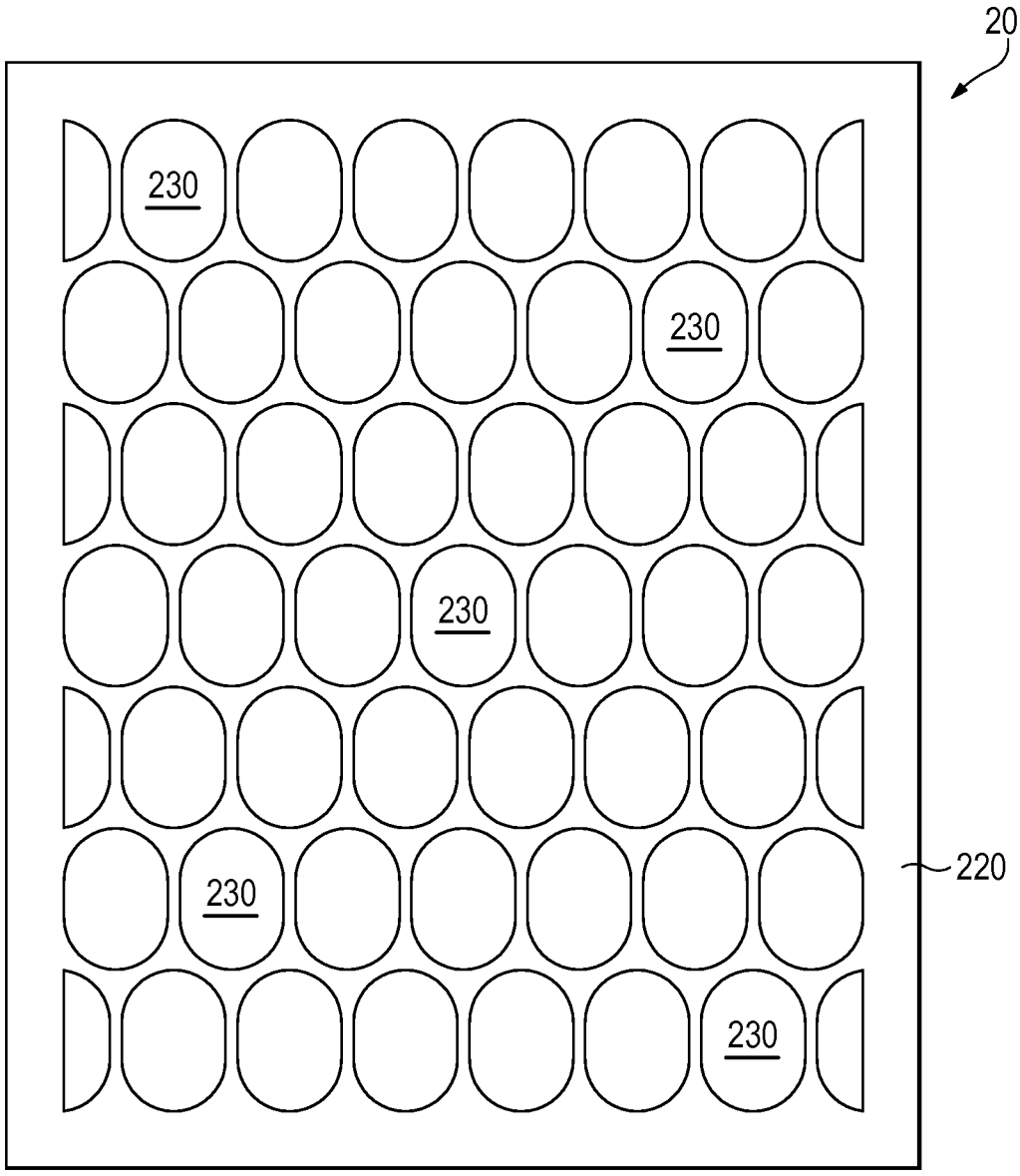

Figure 14P

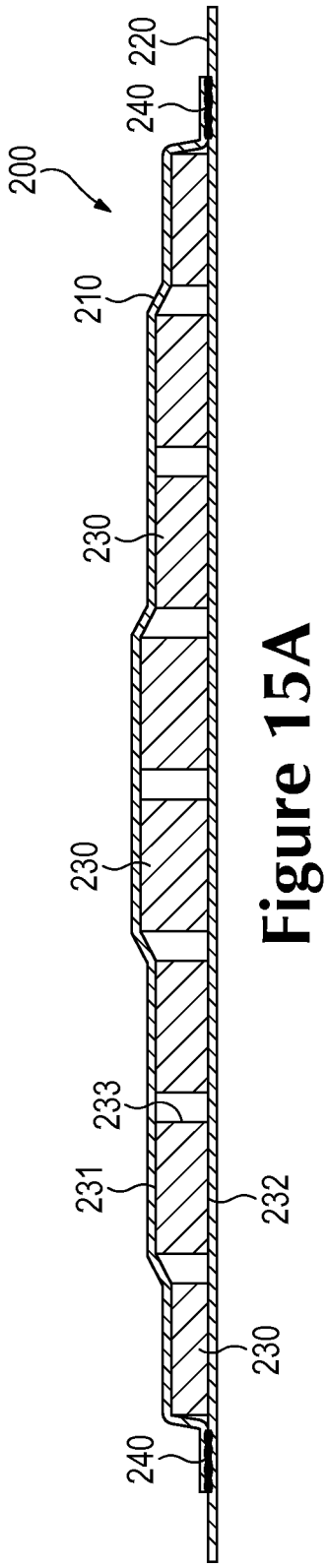

Figure 15A

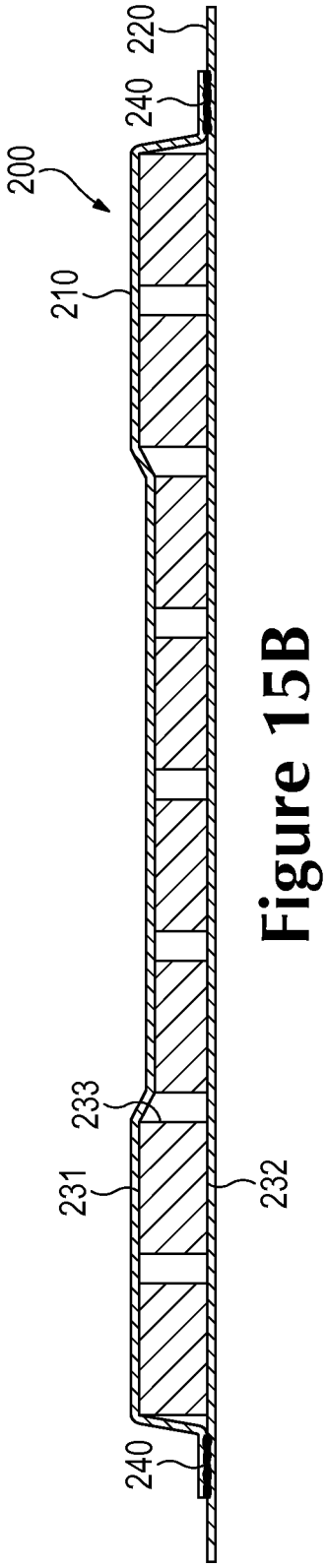

Figure 15B

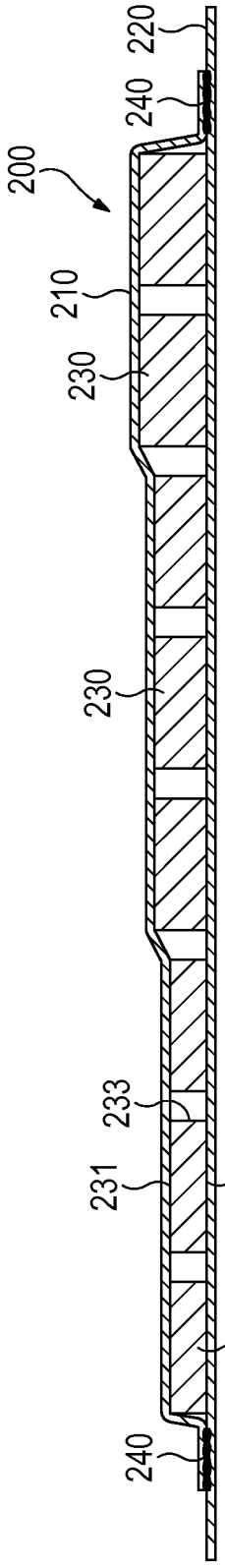

Figure 15C

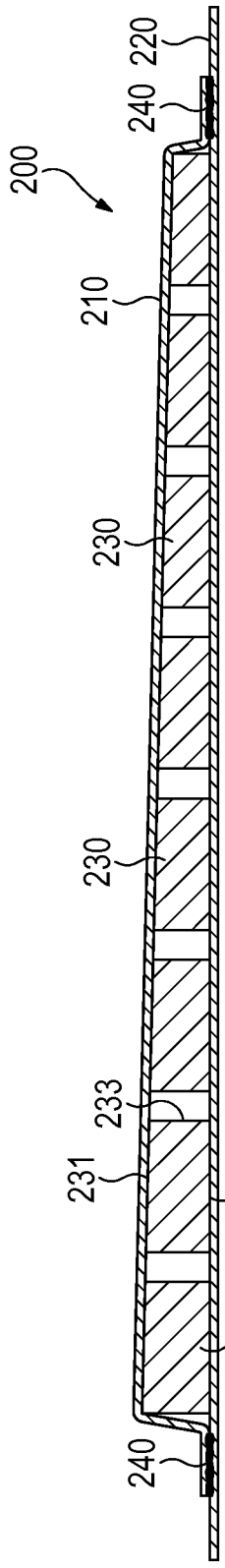

Figure 15D

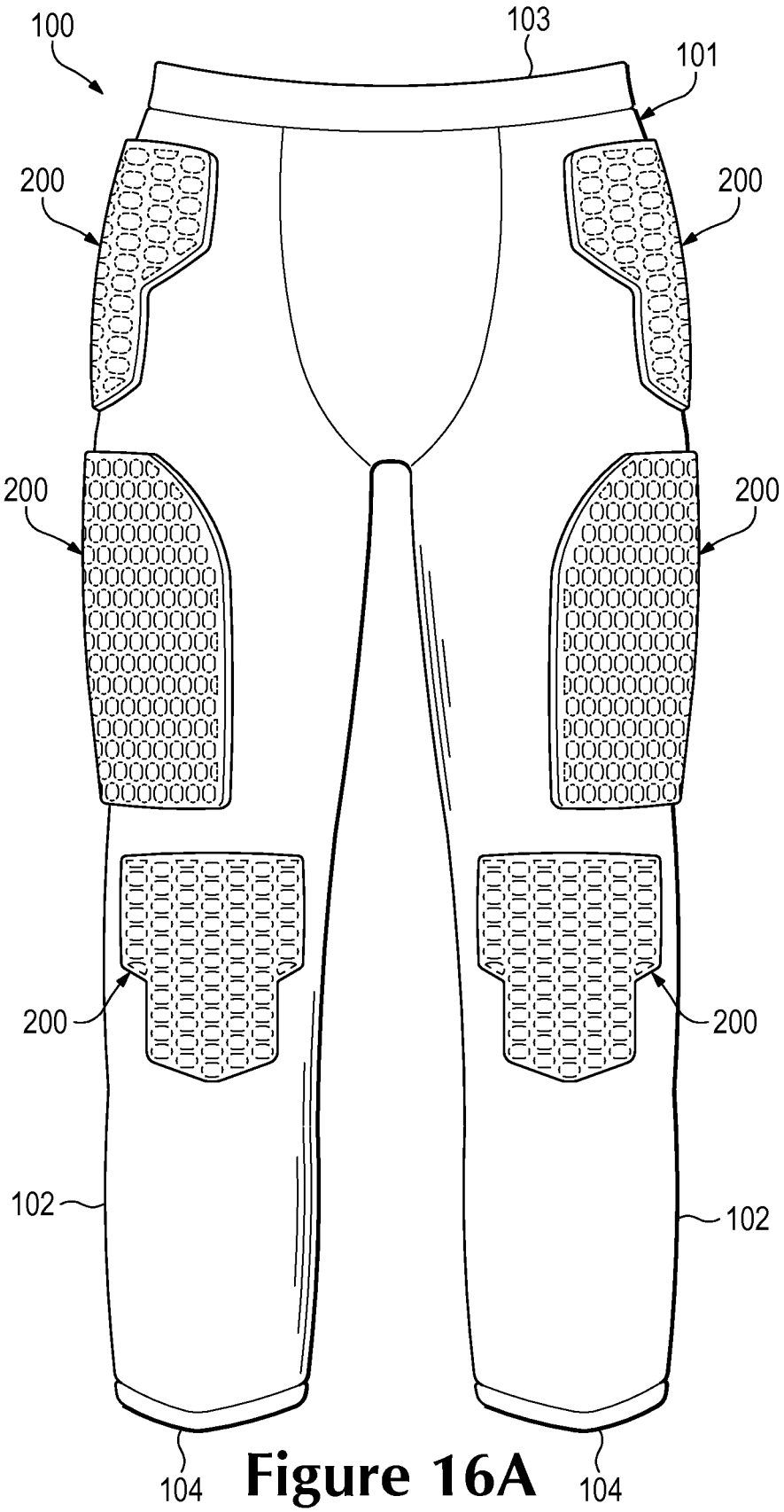

Figure 16A

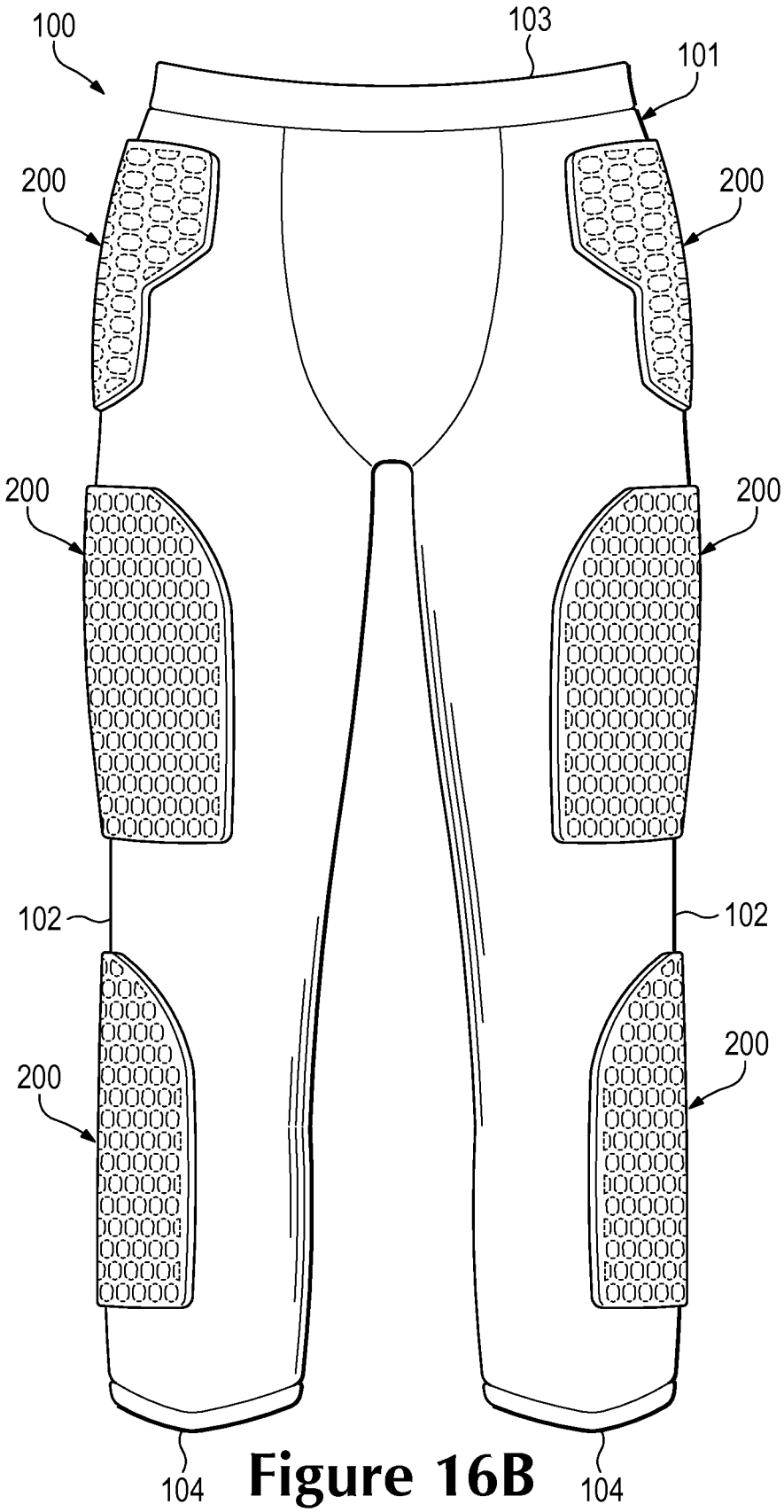

Figure 16B

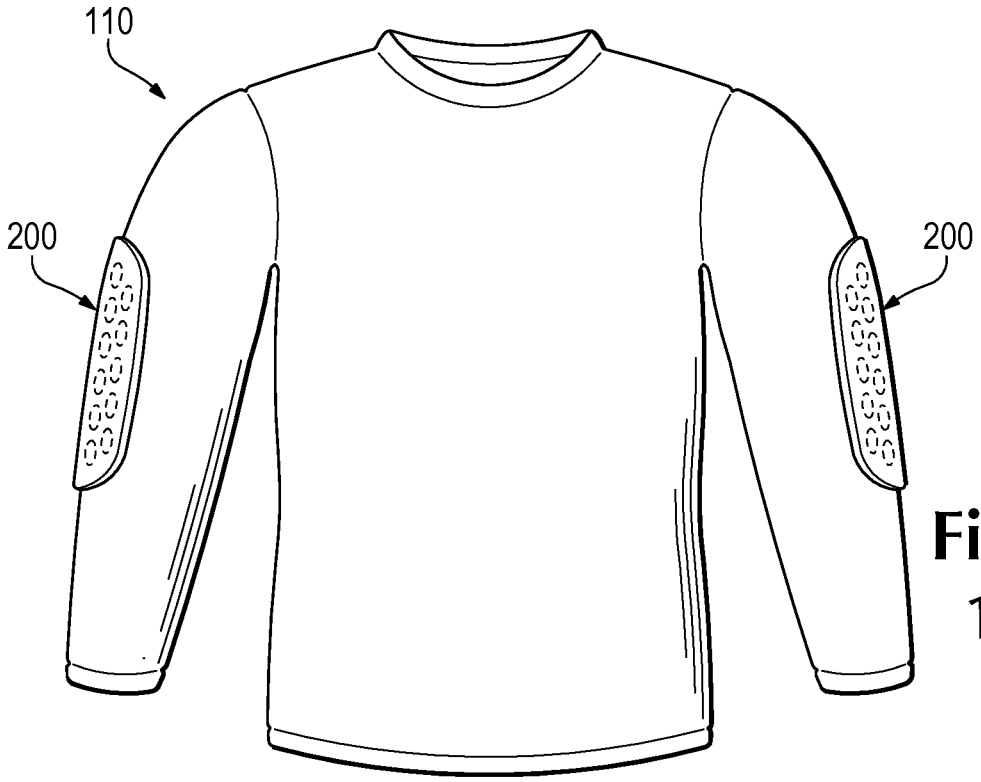

Figure 16C

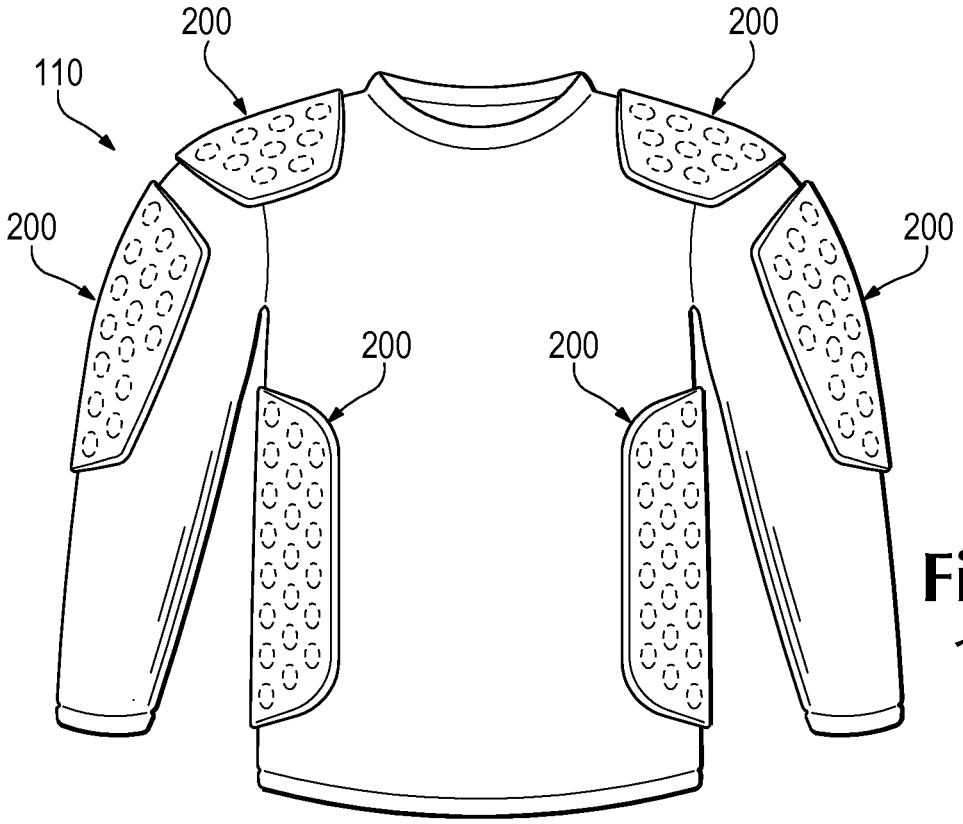

Figure 16D

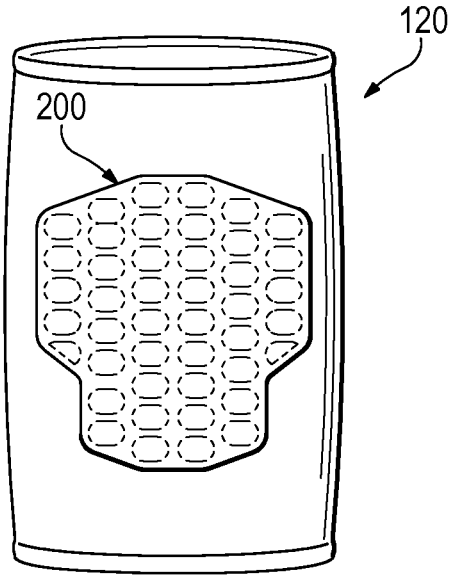

Figure 16E

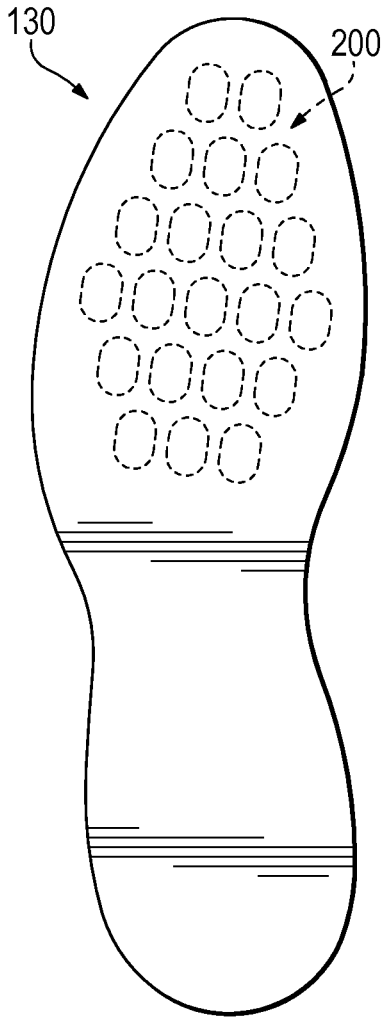

Figure 16F

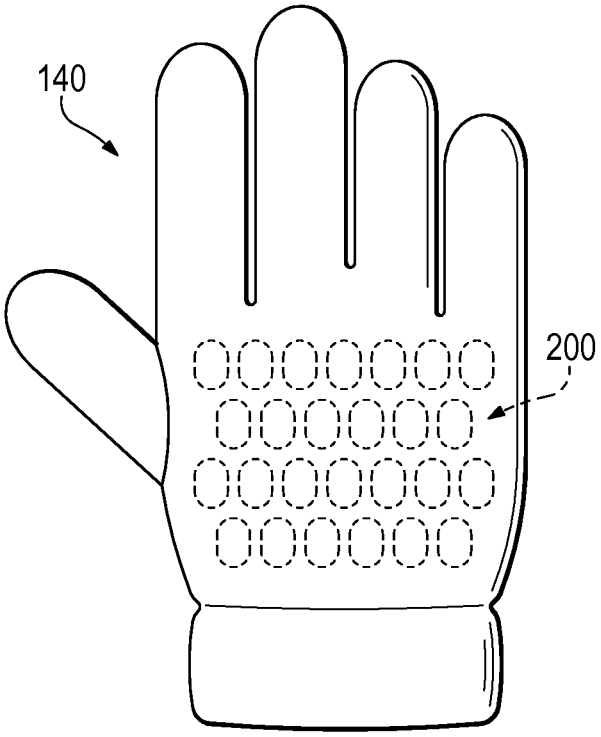

Figure 16G

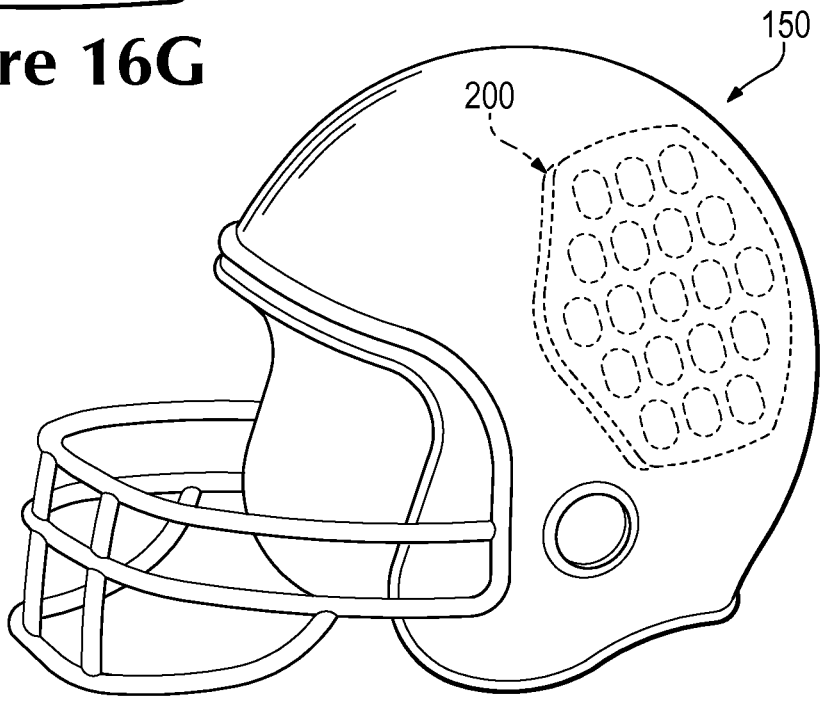

Figure 16H

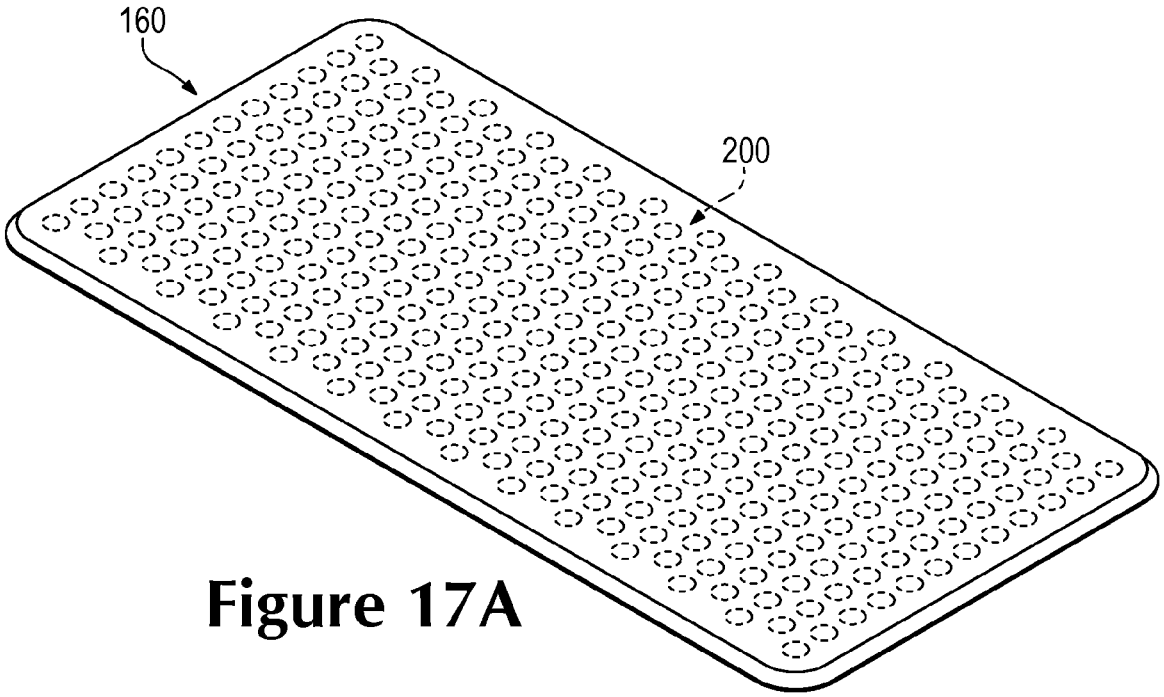

Figure 17A

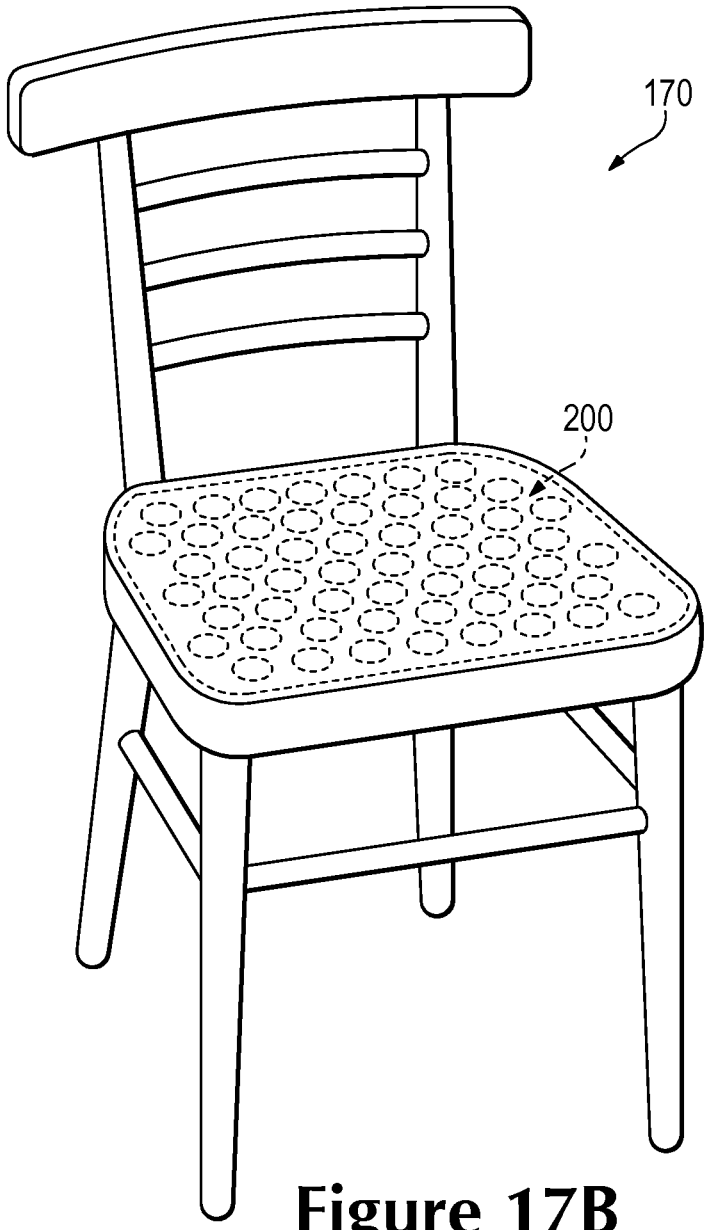

Figure 17B

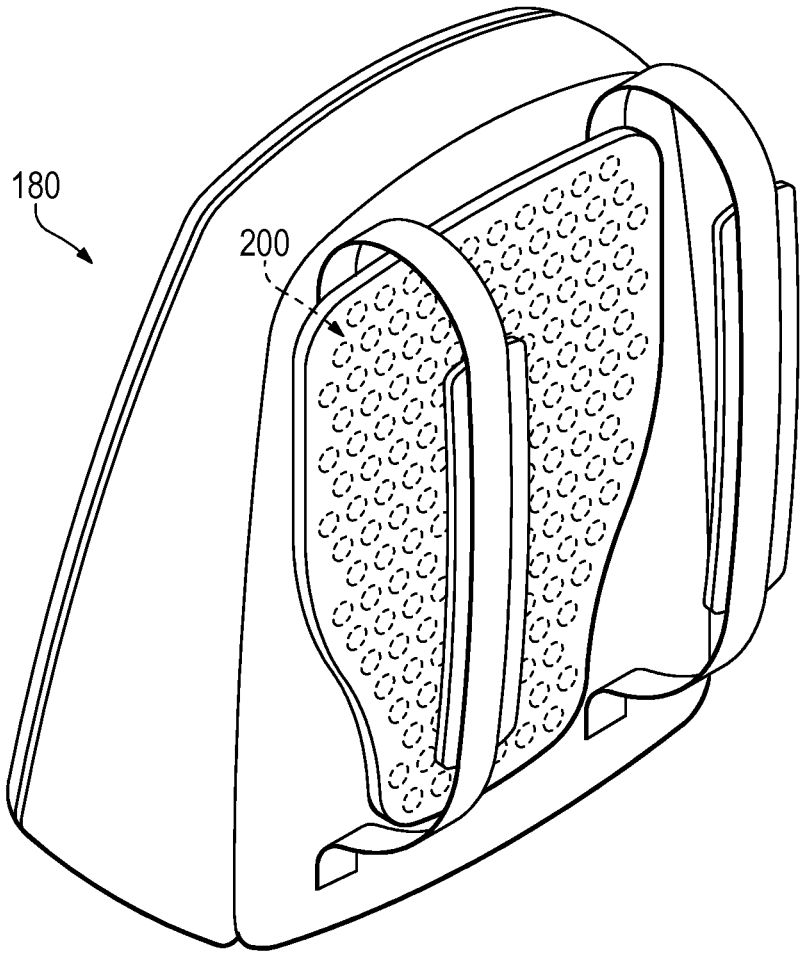

Figure 17C

CUSHIONING ELEMENTS FOR APPAREL AND OTHER PRODUCTS AND METHODS OF MANUFACTURING THE CUSHIONING ELEMENTS

CROSS-REFERENCE To RELATED APPLICATIONS

This U.S. Patent Application is a divisional of U.S. Patent Application Publication Number US 2012/0052249, which is a continuation-in-part of U.S. Pat. No. 8,425,712, both of which are entirely incorporated herein by reference.

BACKGROUND

Materials or elements that impart padding, cushioning, or otherwise attenuate impact forces are commonly incorporated into a variety of products. Athletic apparel, for example, often incorporates cushioning elements that protect the wearer from contact with other athletes, equipment, or the ground. More specifically, pads used in American football and hockey incorporate cushioning elements that provide impact protection to various parts of a wearer. Helmets utilized during American football, hockey, bicycling, skiing, snowboarding, and skateboarding incorporate cushioning elements that provide head protection during falls or crashes. Similarly, gloves utilized in soccer (e.g., by goalies) and hockey incorporate cushioning elements that provide protection to the hands of a wearer. In addition to apparel, mats (e.g., for yoga or camping), chair cushions, and backpacks, for example, all incorporate cushioning elements to enhance comfort.

Various cushioning elements that may be utilized in apparel and a variety of other products are disclosed below. In general, the cushioning elements may include a first material layer, a second material layer, and a plurality of pad components located between and secured to the first material layer and the second material layer. In some configurations, the first material layer and the second material layer are joined through thermalbonding or a combination of thermalbonding and stitching.

Methods for manufacturing the cushioning elements are also disclosed below. In one example, a method includes providing a die and an extractor, the die having a plurality of die elements, and the extractor including a plurality of pins and an extractor sheet, the pins extending through apertures in the extractor sheet. A polymer material is located between the die and the extractor. The polymer material is compressed between the die and the extractor, the die elements cut the polymer material to form a plurality of pad components, and the pins extending into the pad components. The die and the extractor are separated, with the pad components being secured to the pins. The pad components are compressed against a first material layer with the extractor to bond the pad components to the first material layer. The extractor sheet is separated from the pins to push the pad components from the extractor. Additionally, the pad components are compressed against a second material layer to bond the pad components to the second material layer.

In another example of a method for manufacturing the cushioning elements, a plurality of pad components are located between a first material layer and a second material layer. The pad components are joined to the first material layer and the second material layer. Additionally, the first material layer is secured to the second material layer around a perimeter of the pad components with a bonding element.

The advantages and features of novelty characterizing aspects of the invention are pointed out with particularity in the appended claims. To gain an improved understanding of the advantages and features of novelty, however, reference may be made to the following descriptive matter and accompanying figures that describe and illustrate various configurations and concepts related to the invention.

The foregoing Summary and the following Detailed Description will be better understood when read in conjunction with the accompanying figures.

FIG. **1** is a front elevational view of an individual wearing an article of apparel.

FIG. **2** is a front elevational view of the article of apparel.

FIGS. **3** and **4** are side elevational views of the article of apparel.

FIG. **5** is a rear elevational view of the article of apparel.

FIG. **6** is a perspective view of a cushioning element.

FIG. **7** is an exploded perspective view of the cushioning element.

FIG. **8** is a top plan view of the cushioning element.

FIGS. **9**A and **9**B are cross-sectional views of the cushioning element, as defined by section lines **9**A and **9**B in FIG. **8**.

FIG. **10** is a perspective view of portions of a manufacturing apparatus utilized in a manufacturing process for the cushioning element.

FIGS. **11**A-**11**K are schematic perspective views of the manufacturing process.

FIGS. **12**A-**12**K are schematic cross-sectional views of the manufacturing process, as respectively defined by section lines **12**A-**12**K in FIGS. **11**A-**11**K.

FIG. **13** is an exploded perspective views corresponding with FIG. **7** and depicting a further configuration of the cushioning element.

FIGS. **14**A-**14**P are top plan views corresponding with FIG. **8** and depicting further configurations of the cushioning element.

FIGS. **15**A-**15**D are cross-sectional views corresponding with FIG. **9**A and depicting further configurations of the cushioning element.

FIGS. **16**A-**16**H are elevational views of articles of apparel incorporating the cushioning element.

FIGS. **17**A-**17**C are perspective views of further products incorporating the cushioning element.

The following discussion and accompanying figures disclose various cushioning elements that may be incorporated into a variety of products, including articles of apparel (e.g., shorts, pants, shirts, wraps, gloves, helmets, and footwear), mats, seat cushions, and backpacks, for example. Additionally, the following discussion and accompanying figures disclose various processes associated with manufacturing the cushioning elements.

Apparel Configuration

With reference to FIG. **1**, an individual **10** is depicted as wearing an article of apparel **100** with the general configuration of a shorts-type garment. Although apparel **100** may be worn under other articles of apparel, apparel **100** may be worn alone, may be exposed, or may be worn over other articles of apparel. Apparel **100** may also be worn in combination with other pieces of equipment (e.g., athletic or protective equipment). Accordingly, the configuration of apparel **100** and the manner in which apparel **100** is worn by individual **10** may vary significantly.

Apparel **100** is depicted individually in FIGS. **2**-**5** as including a pelvic region **101** and a pair of leg regions **102** that extend outward from pelvic region **101**. Pelvic region **101** corresponds with a pelvic area of individual **10** and covers at least a portion of the pelvic area when worn. An upper area of

pelvic region **101** defines a waist opening **103** that extends around a waist of individual **10** when apparel **100** is worn. Leg regions **102** correspond with a right leg and a left leg of individual **10** and cover at least a portion of the right leg and the left leg when worn. Lower areas of leg regions **102** each define a thigh opening **104** that extends around a thigh of individual **10** when apparel **100** is worn. Additionally, apparel **100** includes an exterior surface **105** that faces away from individual **10** when apparel **100** is worn, and apparel **100** includes an opposite interior surface **106** that faces toward individual **10** and may contact individual **10** when apparel **100** is worn.

A plurality of cushioning elements **200** are incorporated into various areas of apparel **100** to impart padding, cushioning, or otherwise attenuate impact forces. When apparel **100** is worn during athletic activities, for example, cushioning elements **200** may protect individual **10** from contact with other athletes, equipment, or the ground. With regard to apparel **100**, cushioning elements **200** are located in both of pelvic region **101** and leg regions **102** and are positioned, more specifically, to protect the hips, thighs, and tailbone of individual **10**. As described in greater detail below, cushioning elements **200** may be incorporated into a variety of different articles of apparel, and cushioning elements **200** may be positioned in various areas of the articles of apparel to protect specific portions (e.g., muscles, bones, joints, impact areas) of individual **10**. Additionally, the shapes, sizes, and other properties of cushioning elements **200**, as well as the materials and components utilized in cushioning elements **200**, may vary significantly to provide a particular level of protection to the specific portions of individual **10**.

Cushioning Element Configuration

An example configuration for cushioning element **200** is depicted in FIGS. **6-9**B as including a first material layer **210**, a second material layer **220**, a plurality of pad components **230**, and a bonding element **240**. First material layer **210** and second material layer **220** cooperatively form an outer surface or covering for cushioning element **200**. That is, first material layer **210** and second material layer **220** cooperatively form a pocket or void, in which pad components **230** are located. Whereas second material layer **220** is depicted as having a generally planar configuration, first material layer **210** extends over pad components **230** and also along sides of pad components **230**. Bonding element **240** is located between material layers **210** and **220** to join material layers **210** and **220** together. Although cushioning element **200** may be incorporated into apparel **100** in a variety of ways, first material layer **210** may be positioned exterior of second material element **220**, such that cushioning element **200** protrudes outward from apparel **100**. That is, first material layer **210** may form a portion of exterior surface **105**, whereas second material layer **220** may form a portion of both exterior surface **105** and interior surface **106**. Alternately, second material layer **220** may be positioned exterior of first material element **210**, such that cushioning element **200** protrudes inwardly.

A variety of materials may be utilized for first material layer **210** and second material layer **220**, including various textiles, polymer sheets, leather, or synthetic leather, for example. Combinations of these materials (e.g., a polymer sheet bonded to a textile) may also be utilized for material layers **210** and **220**. Although material layers **210** and **220** may be formed from the same material, each of material layers **210** and **220** may also be formed from different materials. With regard to textiles, material layers **210** and **220** may be formed from knitted, woven, non-woven, spacer, or mesh textile components that include rayon, nylon, polyester, polyacrylic, elastane, cotton, wool, or silk, for example. Moreover, the textiles may be non-stretch, may exhibit one-directional stretch, or may exhibit multi-directional stretch. Accordingly, a variety of materials are suitable for first material layer **210** and second material layer **220**.

Pad components **230** are located between and secured to each of material layers **210** and **220**. Each of pad components **230** has a first surface **231** secured to first material layer **210**, an opposite second surface **232** secured to second material layer **220**, and a side surface **233** that extends between surfaces **231** and **232**. Although the shapes of pad components **230** may vary significantly, each of surfaces **231** and **232** are depicted as having an elliptical or generally elongate shape with rounded end areas, and side surface **233** extends in a generally straight fashion between surfaces **231** and **232**. Pad components **230** are also depicted as being spaced evenly from each other and arranged in rows, particularly offset rows, but may be spaced or located in a variety of arrangements. An advantage of arranging pad components **230** in offset rows is that the area between pad components **230** is effectively minimized, while retaining a regular spacing between adjacent pad components **230**.

A variety of materials may be utilized for pad components **230**, including various polymer foam materials that return to an original shape after being compressed. Examples of suitable polymer foam materials for pad components **230** include polyurethane, ethylvinylacetate, polyester, polypropylene, and polyethylene foams. Moreover, both thermoplastic and thermoset polymer foam materials may be utilized. In some configurations of cushioning element **200**, pad components **230** may be formed from a polymer foam material with a varying density, or solid polymer or rubber materials may be utilized. Fluid-filled chambers may also be utilized as pad components **230**. Also, different pad components **230** may be formed from different materials, or may be formed from similar materials with different densities. As discussed in greater detail below, the polymer foam materials forming pad components **230** attenuate impact forces to provide cushioning or protection. By selecting thicknesses, materials, and densities for each of the various pad components **230**, the degree of impact force attenuation may be varied throughout cushioning element **200** to impart a desired degree of cushioning or protection.

The compressible polymer foam materials forming pad components **230** attenuate impact forces that compress or otherwise contact cushioning element **200**. When incorporated into apparel **100** or another article of apparel, for example, the polymer foam materials of pad components **230** may compress to protect a wearer from contact with other athletes, equipment, or the ground. Accordingly, cushioning element **200** may be utilized to provide cushioning or protection to areas of individual **10** or other wearers that are covered by cushioning element **200**.

Bonding element **240** joins material layers **210** and **220** around a perimeter of pad components **230**. Referring to FIG. **7**, for example, bonding element **240** is located at an edge of first material layer **210** and extends entirely around first material layer **210**. Although bonding element **240** is located at a perimeter of first material layer **210**, bonding element **240** is absent from a central area of first material layer **210**. That is, bonding element **240** has an aperture that exposes the central area of first material layer **210**. In effect, therefore, bonding element **240** is absent from the portion of first material layer **210** that joins with pad components **230**. In other configurations, however, bonding element **240** may be located in the central area of first material layer **210** and may be utilized to join pad components **230** to first material layer **210**.

A variety of materials may be utilized for bonding element **240**, including thermoplastic polymer materials (e.g., polyurethane), various adhesives, or heat-activated adhesives, for example. When formed from a thermoplastic polymer material, for example, the application of heat and pressure may be utilized to bond material layers **210** and **220** to each other with bonding element **240**. A thermoplastic polymer material melts when heated and returns to a solid state when cooled sufficiently. Based upon this property of thermoplastic polymer materials, thermalbonding processes may be utilized to form a thermalbond that joins material layer **210** and **220**. As utilized herein, the term "thermalbonding" or variants thereof is defined as a securing technique between two elements that involves a softening or melting of a thermoplastic polymer material within at least one of the elements such that the materials of the elements are secured to each other when cooled. Similarly, the term "thermalbond" or variants thereof is defined as the bond, link, or structure that joins two elements through a process that involves a softening or melting of a thermoplastic polymer material within at least one of the elements such that the materials of the elements are secured to each other when cooled. With regard to bonding element **240**, thermalbonding may involve, for example, the melting or softening of thermoplastic materials within bonding element **240** to join material layers **210** and **220** together. Additionally, thermalbonding does not generally involve the use of stitching or adhesives, but involves directly bonding elements to each other with heat. In some situations, however, stitching or adhesives may be utilized to supplement the thermalbond or the joining of elements through thermalbonding. As an alternative to thermalbonding, an adhesive, a thermally-activated adhesive, or other securing structure may be utilized to join material layers **210** and **220**.

In addition to attenuating impact forces, cushioning element **200** has an advantage of simultaneously providing one or more of breathability, flexibility, a relatively low overall mass, and launderability. When incorporated into an article of apparel, such as apparel **100**, a wearer may perspire and generate excess heat. By utilizing a permeable textile for material layers **210** and **220** and also forming gaps between adjacent pad components **230**, areas for air to enter apparel **100** and for moisture to exit apparel **100** are formed through cushioning element **200**. More particularly, air and moisture may pass through material layers **210** and **220** and between pad components **230** to impart breathability to areas of apparel **100** having cushioning element **200**. Moreover, the materials and structure discussed above for cushioning element **200** impart flexibility and a low overall mass to cushioning element **200**. Furthermore, the materials and structure discussed above for cushioning element **200** permits cushioning element **200** to be laundered without significant shrinkage or warping, even when temperatures associated with commercial laundering processes are utilized. Accordingly, cushioning element **200** may simultaneously provide impact force attenuation, breathability, flexibility, a relatively low overall mass, and launderability to an article of apparel.

Manufacturing Process

A variety of techniques may be utilized to manufacture cushioning element **200**. With reference to FIG. **10**, a manufacturing apparatus **300** is disclosed as including a die **310**, an extractor **320**, a heating plate **330**, and a press plate **340**. The configurations depicted in FIG. **10** and discussed below for manufacturing apparatus **300** are intended to provide an example of a manufacturing apparatus that may be utilized in the manufacture of cushioning element **200**. A variety of other manufacturing apparatuses that operate in a similar manner may also be utilized.

Die **310** includes a base **311**, a plurality of die elements **312**, a plurality of ejection members **313**, and a pair of registration pegs **314**. Base **311** is formed from a durable and rigid material, such as steel or aluminum, to provide a foundation for die **310**. Die elements **312** extend outward (e.g., upward) from base **311** and exhibit a general shape of pad components **230**. More particularly, an interior area of each die element **312** has the general shape of an individual pad component **230**. As discussed in greater detail below, edges **315** (e.g., upper edges) of die elements **312** are utilized to cut through a material that forms pad components **230**, thereby shaping and forming each of pad components **230**. Edges **315** may generally have a sharpened configuration that assists with cutting through the material that forms pad components **230**. Ejection members **313** are located within the interior areas of each die element **312** and are spaced (e.g., spaced downward) from edges **315**. As an example, ejection members **313** may be formed from a polymer foam material with lesser compressibility than a polymer foam material forming pad components **230**. Additionally, registration pegs **314** extend outward (e.g., upward) from base **311**.

In addition to having the general shape of pad components **230**, die elements **312** are arranged or otherwise located relative to each other in the same manner as pad components **230**. As noted above, pad components **230** are depicted as being spaced evenly from each other and arranged in offset rows. Similarly, die elements **312** are spaced evenly from each other and arranged in offset rows. That is, die elements **312** are arranged in a configuration that corresponds with the positions of pad components **230** in cushioning element **200**. If, however, a different arrangement is desired for pad components **230**, then die elements **312** may be moved or otherwise repositioned to correspond with the different arrangement.

Extractor **320** includes a base **321**, a plurality of extractor elements **322**, a pair of registration apertures **323**, and an extractor sheet **324**. Base **321** is formed from a durable and rigid material, such as steel or aluminum, to provide a foundation for extractor **320**. Extractor elements **322** have the configurations of pins that extend outward (e.g., downward) from base **321** and have sharpened or pointed end areas. As discussed in greater detail below, extractor elements **322** assist with retaining the positions of pad components **230** upon removal from die **310**. As an alternative to pins, extractor elements **322** (a) may have the configurations of needles, nails, spikes, or prongs or (b) may be a vacuum system that retains the positions of pad components **230** upon removal from die **310**, for example Accordingly, extractor elements **322** are any device or system that may be used to secure pad components **230** to extractor **320** and assist with retaining the positions of pad components **230** upon removal from die **310**. Additionally, registration apertures **323** form holes in base **321** that are positioned to correspond with and receive registration pegs **314**.

The positions of extractor elements **322** correspond with the locations of die elements **312**. Moreover, extractor elements **322** are arranged or otherwise located relative to each other in the same manner as die elements **312**, and die elements **313** are arranged or otherwise located relative to each other in the same manner as pad components **230**. That is, extractor elements **322** are arranged in a configuration that corresponds with the positions of pad components **230** in cushioning element **200**. If, however, a different arrangement is desired for pad components **230**, then extractor elements **322** and die elements **312** may be moved or otherwise repositioned to correspond with the different arrangement.

Extractor sheet **324** lays adjacent to base **321** and includes a plurality of apertures that receive extractor elements **322**.

That is, extractor elements **322** extend through the apertures in extractor sheet **324**. A variety of materials may be utilized for extractor sheet **324**, including various polymer materials and metals.

Heating plate **330** includes a base **331** that may also be formed from a durable and rigid material, such as steel or aluminum, and incorporates heating elements. More particularly, electric coils may extend through base **331** to heat base **331** to temperatures that bond (a) pad components **230** to material layers **210** and **220** and (b) material layers **210** and **220** to each other with bonding element **240**. As an alternative, base **331** may incorporate fluid channels through which a heated fluid passes, or radiant heaters, radio frequency emitters, or other devices may be utilized. In some configurations of heating plate **330**, a surface of base **331** that contacts portions of cushioning element **200** during the manufacturing process may incorporate a rubber or silicone material.

Press plate **340** includes a base **341** and a compressible material **342**. As with bases **311**, **321**, and **331**, base **341** may be formed from a durable and rigid material, such as steel or aluminum. Compressible material **342** is recessed within a surface of base **341** and is formed from a material (e.g., silicone, polymer foam) that compresses or deforms when a force is applied and returns to an original shape when the force is removed. Although a single element of compressible material **342** is depicted, some configurations may incorporate multiple elements of compressible material **342** with different degrees of compressibility, depending upon the configuration of cushioning element **200** that is being manufactured.

With reference to FIGS. **11**A-**11**K and **12**A-**12**K, an example of a suitable manufacturing process utilizing manufacturing apparatus **300** is disclosed. Initially, die elements **312** are arranged in a configuration that corresponds with the positions of pad components **230** in cushioning element **200**, and extractor elements **322** are arranged in a configuration that corresponds with the positions of die elements **312** and pad components **230** in cushioning element **200**. A blank **301** is then placed between die **310** and extractor **320**, as depicted in FIGS. **11**A and **12**A. Blank **301**, from which pad components **230** are cut, is formed from the same material as pad components **230** and has a thickness of pad components **230**. Once blank **301** is positioned, die **310** and extractor **320** close upon, compress, and cut blank **301**, as depicted in FIGS. **11**B and **12**B. More particularly, (a) blank **301** is compressed against die elements **312** such that edges **315** pierce and cut through blank **301** and (b) extractor elements **322** pierce and enter blank **301**. Note that extractor elements **322** are positioned to correspond with each of die elements **312** and enter the interior area of each of die elements **312**, which is where ejection members **313** are located. Depending upon the lengths of extractor elements **322**, end areas of extractor elements **322** may pass through blank **301** and pierce ejection members **313** during this operation. In order to ensure that die elements **312** properly align with extractor elements **322**, registration pegs **314** are aligned with and enter registration apertures **323**.

At this stage of the process, die elements **312** have effectively cut through blank **301**. Referring to FIG. **12**B, edges **315** of die elements **312** pass entirely through blank **301** to rest against a surface of extractor sheet **324**. As noted above, the interior area of each die element **312** has the general shape of an individual pad component **230**. Accordingly, the individual pad components **230** are located within die elements **312** and are compressed between a surface of extractor sheet **324** and ejection members **313**. As depicted in FIGS. **11**C and **12**C, die **310** and extractor **320** then separate to remove pad components **230** from within die elements **312**, and pad components **230** are secured to extractor **320** by the various extractor elements **322**. Referring again to FIG. **12**B, portions of blank **301** within die elements **312** (i.e., the portions forming pad components **230**) are compressed more than portion of blank **301** that are exterior of die elements **312**. That is, portions of blank **301** within die elements **312** are compressed against ejection members **313**. When die **310** and extractor **320** separate, the compression of pad components **230** causes pad components **230** to expand outward from die elements **312** and remain properly positioned on extractor elements **322**. As a result, pad components **230** remain secured to extractor elements **322** upon the separation of die **310** and extractor **320**. Additionally, note that blank **301** may remain within die **310** (i.e., around the various die elements **312**) at this stage, or may be separated from die **310**, and also that blank **301** defines various apertures where pad components **230** were removed.

Referring to FIG. **12**C, extractor elements **322** extend through and protrude from pad components **230**. An advantage of this configuration is that extractor elements **322** may have a length that is suitable for a variety of thicknesses in pad components **230**. As described in greater detail below, extractor elements **322** may also have a configuration that retracts into base **321**, thereby facilitating future bonding steps or accommodating configurations where pad components **230** have different thicknesses.

As a summary of the manufacturing process up to this point, pad components **230** have effectively been removed from blank **301**. More particularly, (a) die elements **312** were utilized to cut through blank **301** to form pad components **230** and (b) pad components **230** are removed from die elements **312** and remain secured to extractor **320** due to the presence of extractor elements **322**, which extend into the various pad components **230**. Additionally, pad components **230** are positioned and oriented in the same manner as die elements **312** and are, therefore, positioned and oriented as within cushioning element **200**. Accordingly, pad components **230** have been removed from blank **301** and are positioned and oriented to be incorporated into cushioning element **200**.

The combination of extractor **320** and pad components **230** is then positioned adjacent to heating plate **330**, as depicted in FIGS. **11**D and **12**D. Additionally, first material layer **210** is placed between pad components **230** and heating plate **330**. Extractor **320** and heating plate **330** then close upon and compress first material layer **210** and pad components **230**, as depicted in FIGS. **11**E and **12**E. As discussed above, base **331** of heating plate **330** incorporates heating elements. As such, the temperature of base **331** may be elevated to a point where bonding occurs between first material layer **210** and pad components **230**. Although extractor elements **322** are depicted as protruding into heating plate **330**, extractor elements **322** may have a retractable configuration that retracts into base **321**.

When compressed between extractor **320** and heating plate **330**, energy from heating plate **330** may be utilized to bond first material layer **210** and pad components **230** to each other. As discussed above, a thermoplastic polymer material melts when heated and returns to a solid state when cooled sufficiently. Based upon this property of thermoplastic polymer materials, thermalbonding processes may be utilized to form a thermalbond that joins first material layer **210** are pad components **230**. In this context, thermalbonding may involve, for example, (a) the melting or softening of thermoplastic materials within either of first material layer **210** and pad components **230** that joins the elements together, (b) the melting or softening of a thermoplastic material within pad components

230 such that the thermoplastic polymer material extends into or infiltrates the structure of a textile utilized for first material layer 210, or (c) the melting or softening of a thermoplastic material within first material layer 210 such that the thermoplastic polymer material extends into or infiltrates the structure of pad components 230. Thermalbonding may occur when only one element includes a thermoplastic polymer material or when both elements include thermoplastic polymer materials. Additionally, thermalbonding does not generally involve the use of stitching or adhesives, but involves directly bonding elements to each other with heat. In some situations, however, stitching or adhesives may be utilized to supplement the thermalbond or the joining of elements through thermalbonding. As an alternative to thermalbonding, an adhesive, a thermally-activated adhesive, or other securing structure may be utilized to join first material layer 210 and pad components 230.

As discussed above, a surface of base 331 that contacts portions of cushioning element 200 during the manufacturing process may incorporate a rubber or silicone material. Referring to FIG. 12E, extractor elements 322 are spaced from and do not contact base 331. In situations where the compression of first material layer 210 and pad components 230 induces extractor elements 322 to contact base 331, the rubber or silicone material may be present to receive end areas of extractor elements 322. That is, the end areas of extractor elements 322 may pierce and enter the rubber or silicone material during the compression of first material layer 210 and pad components 230.

Following compression and bonding, extractor 320 and heating plate 330 separate to expose the bonded first material layer 210 and pad components 230. At this stage, the thermoplastic material, adhesive, or other element that joins first material layer 210 and pad components 230 may have an elevated temperature or may not be fully cured. In order to prevent separation between first material layer 210 and pad components 230, extractor sheet 324 may be pulled from base 321, which effectively pushes pad components 230 from extractor elements 322, as depicted in FIGS. 11F and 12F. That is, extractor sheet 324 is separated from extractor elements 322 to push pad components 230 from extractor 320. Upon fully separating extractor sheet 324 from extractor elements 322, the combination of first material layer 210 and pad components 230 is free from extractor 320, as depicted in FIGS. 11G and 12G.

Continuing with the manufacturing of cushioning element 200, second material layer 220 is then placed adjacent to heating plate 330, the combination of first material layer 210 and pad components 230 is turned over or otherwise oriented such that pad components 230 are between material layers 210 and 220, and press plate 340 is located adjacent to first material layer 210, as depicted in FIGS. 11H and 12H. Press plate 340 and heating plate 330 then close upon and compress first material layer 210, second material layer 220, and pad components 230, as depicted in FIGS. 11I and 12I. Given the elevated temperature of base 331, bonding (e.g., thermalbonding) occurs between second material layer 220 and pad components 230.

In addition to bonding second material layer 220 and pad components 230, material layers 210 and 220 are bonded (e.g., thermalbonded) with bonding element 240. Pad components 230 are positioned to correspond with the location of compressible element 342, as depicted in FIG. 12I. When compressed, the thicknesses of pad components 230 and compressible element 342 are reduced, thereby allowing base 331 and base 341 to compress bonding element 240 between material layers 210 and 220. By compressing these elements together, coupled with heat from base 331, second material layer is bonded (e.g., thermalbonded) to bonding element 240. In effect, therefore, material layers 210 and 220 are bonded together with bonding element 240. In configurations where pad components 230 have varying thicknesses, for example, multiple elements of compressible material 342 with different degrees of compressibility may be utilized to ensure that all elements of cushioning element 200 are properly bonded.

Once compression and bonding are complete, heating plate 330 and press plate 340 separate to expose the bonded first material layer 210, second material layer 220, and pad components 230, as depicted in FIGS. 11J and 12J. At this stage of the manufacturing process, the manufacture of cushioning element 200 is effectively complete.

The above discussion of FIGS. 11A-11J and 12A-12J provides an example of a suitable manufacturing process for cushioning element 200. In general, an advantage of the manufacturing process is that the arrangement of die elements 312 determines the resulting arrangement of pad components 230 in cushioning element 200. That is, die 310 is initially set such that die elements 312 are positioned in a particular arrangement, and the resulting positions of pad components 230 effectively mirrors the arrangement of die elements 312. Accordingly, the positions of pad components 320 may be pre-selected through the arrangement of die elements 312.

An additional advantage of the manufacturing process is that all the elements of cushioning element 200 may be joined through thermalbonding without the need for additional manufacturing steps. In some configurations, however, optional stitching, adhesive, or thermalbonding steps may be utilized to supplement the joining of material layers 210 and 220 around the periphery of pad components 230. As an example, referring to FIGS. 11K and 12K, a sewing or stitching machine 350 may be utilized to further secure material layers 210 and 220 to each other. Additionally, sewing or stitching machine 350 may be utilized to incorporate cushioning element 200 into apparel 100 or another article.

A variety of other manufacturing processes or variations of the manufacturing process discussed above may also be utilized. For example, extractor elements 322 may retract such that extractor 320 may also be utilized as press plate 340. In other configurations, ejection material 313 may be absent or a mechanized ejector may be utilized within die elements 312. Moreover, extractor elements 322 may be removable or positioned in various locations to allow different configurations of pad components 230. Moreover, specialized machinery may be formed to automate the general manufacturing process discussed above.

As a further matter, extractor 320 and press plate 340 are depicted as being located below heating plate 330 in various steps. An advantage to this configuration relates to the positioning of elements forming cushioning element 200. More particularly, when extractor 320 and press plate 340 are below heating plate 330, the elements forming cushioning element 200 may be arranged or otherwise positioned on extractor 320 and press plate 340 prior to the application of heat from heating plate 330. In this configuration, heat is applied to the elements of cushioning element 200 only when heating plate 330 compresses the elements against either extractor 320 or press plate 340. Accordingly, the elements forming cushioning element 200 may be arranged in the absence of applied heat in configurations where heating plate 330 is above extractor 320 and press plate 340.

A variety of techniques may be utilized to incorporate cushioning element 200 into apparel 100 or other articles of

apparel. As an example, cushioning element **200** may be stitched or otherwise bonded to other materials forming apparel **100**. In some configurations, cushioning element **200** may have the configuration depicted in FIG. **6**, wherein (a) the second material layer **220** extends outward beyond the periphery of first material layer **210**. In this configuration, second material layer **220** may be part of a larger material element that forms portions of apparel **100**. That is, second material layer **220** may form interior surface **106** of apparel **100**, as well as exterior surface **105** in areas where cushioning elements **200** are absent. In other configurations, cushioning element **200** may be oriented such that first material layer **210** forms a portion of interior surface **106**. Accordingly, the manner in which cushioning element **200** is incorporated into apparel **100** may vary.

Further Cushioning Element Configurations

Aspects of cushioning element **200** may vary, depending upon the intended use for cushioning element **200** and the product in which cushioning element **200** is incorporated. Moreover, changes to the dimensions, shapes, and materials utilized within cushioning element **200** may vary the overall properties of cushioning element **200**. That is, by changing the dimensions, shapes, and materials utilized within cushioning element **200**, the compressibility, impact force attenuation, breathability, flexibility, and overall mass of cushioning element **200** may be tailored to specific purposes or products. A plurality of variations for cushioning element **200** are discussed below. Any of these variations, as well as combinations of these variations, may be utilized to tailor the properties of cushioning element **200** to an intended use or particular product. Moreover, any of these variations may be manufactured through the process or variations of the process discussed above.

A further configuration of cushioning element **200** is depicted in FIG. **13**, wherein a frame component **250** is positioned to extend around and between various pad components **230**. Although pad components **230** are secured to material layers **210** and **220**, frame component **250** may be unsecured to layers **210** and **220**, and a thickness of frame component **250** may be less than the thickness of pad components **230**. An advantage of frame component **250** relates to providing additional protection when objects contact cushioning element **200** and protrude between pad components **230**.

As discussed above, pad components **230** have an elliptical or generally elongate shape with rounded end areas. Pad components **230** may, however, have a variety of other shapes, including round, triangular, and hexagonal, as respectively depicted in FIGS. **14**A-**14**C. Pad components **230** may have an irregular shape, as depicted in FIG. **14**D, or may be a mixture of different shapes, as depicted in FIG. **14**E. Although each of pad components **230** may have the same shape and size, pad components **230** may also have generally similar shapes with a variety of different sizes, as depicted in FIG. **14**F.

In addition to aspects of pad components **230** that may vary significantly, the overall shape of cushioning element **200** may vary. Referring to FIG. **14**G, cushioning element **200** exhibits a generally round or circular shape. In further configurations, cushioning element **200** may have a triangular, hexagonal, or H-shaped structure, as respectively depicted in FIGS. **14**H-**14**J. Various shapes for cushioning element **200** are also depicted in association with apparel **100** in FIGS. **1**-**5**. As examples of these, one of cushioning elements **200** from apparel **100** that has a shape suitable for a hip pad is depicted in FIG. **14**K, one of cushioning elements **200** from apparel **100** that has a shape suitable for a thigh pad is depicted in FIG. **14**L, and one of cushioning elements **200** from apparel **100** that has a shape suitable for a tailbone pad is depicted in FIG. **14**M. A configuration for cushioning element **200** that has a shape suitable for an elbow pad (e.g., for a shirt, jacket, or arm sleeve) is depicted in FIG. **14**N.

Various aspects relating to first material layer **210** and second material layer **220** may also vary significantly. As discussed above, material layers **210** and **220** may be formed from various textiles, polymer sheets, leather, synthetic leather, or combinations of materials, for example. Referring to FIG. **140**, first material layer **210** is depicted as having the configuration of a mesh material that defines a plurality of holes, through which pad components **230** and frame component **250** are visible. In addition to imparting greater breathability that allows the transfer of air and moisture, a mesh material may allow for various aesthetic properties. More particularly, pad components **230** may have different colors that are visible through first material layer **210**. In addition to a mesh material, other at least semi-transparent textile or polymer sheet materials may also permit pad components **230** with different colors to be visible. In further configurations, first material layer **210** may be entirely absent from cushioning element **200**, as depicted in FIG. **14**P.

Although the thicknesses of pad components **230** (i.e., distance between surfaces bonded to material layers **210** and **220**) may be constant, pad components **230** may also have varying thicknesses, as depicted in FIG. **15**A. In some configurations of cushioning element **200**, pad components **230** located in the central area may have lesser thickness than pad components **230** located in the peripheral area, as depicted in FIG. **15**B. The thicknesses of pad components **230** may also decrease across the width of cushioning element **200**, as depicted in FIG. **15**C, or may taper across the width of cushioning element **200**, as depicted in FIG. **15**D.

Further Apparel And Product Configurations

Apparel **100** is depicted in FIGS. **1**-**5** as having the general configuration of a shorts-type garment. Referring to FIG. **16**A, leg regions **102** of apparel **100** extend downward to a greater degree, thereby imparting the configuration of a pants-type garment that includes additional cushioning elements **200** for the knees of individual **10**. A similar configuration is depicted in FIG. **16**B, wherein apparel **100** includes additional cushioning elements **200** for the ankles or lower legs of individual **10**.

In addition to shorts-type garments and pants-type garments, a variety of other types of apparel may also incorporate cushioning elements **200** in any of the configurations discussed above. Referring to FIG. **16**C, an article of apparel **110** having the configuration of a shirt-type garment is depicted as including two cushioning elements **200** in locations that correspond with elbows of a wearer. When worn, cushioning elements **200** may provide protection to the elbows. That is, cushioning elements **200** may attenuate impact forces upon the elbows. In addition to attenuating impact forces, cushioning elements **200** may also simultaneously provide one or more of breathability, flexibility, a relatively low overall mass, and launderability. Although apparel **110** is depicted as a long-sleeved shirt, apparel **110** may have the configuration of other shirt-type garments, including short-sleeved shirts, tank tops, undershirts, jackets, and coats, for example. Referring to FIG. **16**D, apparel **110** is depicted as including six cushioning elements **200** in locations that correspond with elbows, shoulders, and sides of a wearer.

Cushioning elements **200** may also be incorporated into apparel that covers other areas of the wearer, such as hats, helmets, wraps, footwear, socks, and gloves, for example. As an example, a wrap **120** with one cushioning element **200** is depicted in FIG. **16**E. Wrap **120** has a generally cylindrical

configuration that may be placed upon an arm or a leg of a wearer. When, for example, the elbow is sore or injured, cushioning element **200** of wrap **120** may be located over the elbow to assist with protecting the elbow during athletic activities. As another example, a sockliner **130** that incorporates a cushioning element **200** is depicted in FIG. **16**F. Sockliner **130** may be located within an article of footwear to cushion a lower (i.e., plantar) surface of the foot. Additionally, one or more cushioning elements **200** may be incorporated into a glove **140**, as depicted in FIG. **16**G, to impart protection to a hand of the wearer. One or more cushioning elements **200** may also be incorporated into a helmet **150**, as depicted in FIG. **16**H, to impart protection to a head of the wearer. In addition to attenuating impact forces, cushioning elements **200** in these configurations may also simultaneously provide one or more of breathability, flexibility, a relatively low overall mass, and launderability.

Cushioning elements **200** may also be utilized in products other than apparel. Referring to FIG. **17**A, a mat **160** is depicted as being primarily formed from one cushioning element **200**. Mat **160** may be utilized, for example, during yoga or as a camping pad to provide a comfortable surface for sitting or laying on the ground. A cushioning element **200** may also be incorporated into a chair **170**, as depicted in FIG. **17**B, to provide a comfortable place to sit. Similarly, a cushioning element **200** may be incorporated into a cushion that may be placed upon a chair or upon bleachers at a sporting event, for example. Also, a cushioning element **200** may be incorporated into a backpack **180**, as depicted in FIG. **17**C, to provide cushioning against the back of the wearer. Accordingly, various configurations of cushioning elements **200** may be incorporated into a plurality of products.

The invention is disclosed above and in the accompanying figures with reference to a variety of configurations. The purpose served by the disclosure, however, is to provide an example of the various features and concepts related to the invention, not to limit the scope of the invention. One skilled in the relevant art will recognize that numerous variations and modifications may be made to the configurations described above without departing from the scope of the present invention, as defined by the appended claims.

The invention claimed is:

1. A method of manufacturing a cushioning element, the method comprising:

providing a die and an extractor, the die having a plurality of die elements, and the extractor including a plurality of pins and an extractor sheet, the pins extending through apertures in the extractor sheet;

locating a polymer material between the die and the extractor;

compressing the polymer material between the die and the extractor, the die elements cutting the polymer material to form a plurality of pad components, and the pins extending into the pad components;

separating the die and the extractor, the pad components being secured to the pins;

compressing the pad components against a first material layer with the extractor to bond the pad components to the first material layer;

separating the extractor sheet from the pins to push the pad components from the extractor; and

compressing the pad components against a second material layer to bond the pad components to the second material layer.

2. The method recited in claim **1**, wherein the step of providing further includes locating the pins opposite the die elements.

3. The method recited in claim **1**, wherein the step of providing includes positioning the die elements and the pins in offset rows.

4. The method recited in claim **1**, wherein the step of compressing the pad components against the first material layer includes forming a thermalbond between the pad components and the first material layer.

5. The method recited in claim **1**, further comprising the step of separating the extractor sheet and the pad components prior to the step of compressing the pad components against the second material layer.

6. The method recited in claim **1** further comprising the steps of

positioning the extractor proximate a heating plate so that the pad components are disposed between the extractor and the heating plate;

placing the first material layer between the pad components and the heating plate prior to the step of compressing the pad components against the first material layer with the extractor to bond the pad components to the first material layer.

7. A method of manufacturing a cushioning element, the method comprising:

providing a die and an extractor, the die having a plurality of die elements, and the extractor including a plurality of pins and an extractor sheet, the pins extending through apertures in the extractor sheet;

locating a polymer material between the die and the extractor;

compressing the polymer material between the die and the extractor, the die elements cutting the polymer material to form a plurality of pad components, and the pins extending into the pad components;

separating the die and the extractor, the pad components being secured to the pins;

compressing the pad components against a first material layer with the extractor to bond the pad components to the first material layer;

separating the extractor sheet from the pins to push the pad components from the extractor;

separating the extractor sheet and the pad components;

positioning a second material layer against the pad components; and

compressing the pad components against the second material layer to bond the pad components to the second material layer.

8. The method recited in claim **7**, wherein the step of providing further includes locating the pins opposite the die elements.

9. The method recited in claim **7**, wherein the step of providing includes positioning the die elements and the pins in offset rows.

10. The method recited in claim **7**, wherein the step of compressing the pad components against the first material layer includes forming a thermalbond between the pad components and the first material layer.

11. The method recited in claim **7** further comprising the step of positioning the extractor proximate a heating plate so that the pad components are disposed between the extractor and the heating plate.

12. The method recited in claim **11** further comprising the step of placing the first material layer between the pad components and the heating plate prior to the step of compressing the pad components against the first material layer with the extractor to bond the pad components to the first material layer.

13. The method recited in claim 11, wherein the step of positioning the second material layer against the pad components includes placing the second material layer between the pad components and the heating plate.

14. A method of manufacturing a cushioning element, the method comprising:

providing a die and an extractor, the die having a plurality of die elements, and the extractor including a plurality of pins and an extractor sheet, the pins extending through apertures in the extractor sheet;

locating a polymer material between the die and the extractor;

compressing the polymer material between the die and the extractor, the die elements cutting the polymer material to form a plurality of pad components, and the pins extending into the pad components;

separating the die and the extractor, the pad components being secured to the pins;

positioning the extractor proximate a heating plate so that the pad components are disposed between the extractor and the heating plate;

placing a first material layer between the pad components and the heating plate;

compressing the pad components against a first material layer with the extractor to bond the pad components to the first material layer;

separating the extractor sheet from the pins to push the pad components from the extractor;

separating the extractor sheet and the pad components;

positioning a second material layer against the pad components; and

compressing the pad components against the second material layer to bond the pad components to the second material layer.

15. The method recited in claim 14, wherein the step of providing further includes locating the pins opposite the die elements.

16. The method recited in claim 14, wherein the step of providing includes positioning the die elements and the pins in offset rows.

17. The method recited in claim 14, wherein the step of compressing the pad components against the first material layer includes forming a thermalbond between the pad components and the first material layer.

18. The method recited in claim 14 further comprising the step of positioning the heating plate proximate a press plate prior to the step of positioning the second material layer against the pad components.

19. The method recited in claim 18, wherein the step of positioning the second material layer against the pad components includes positioning the second material layer between the pad components and the heating plate and positioning the first material layer between the pad components and the press plate.

20. The method recited in claim 14, wherein the step of compressing the pad components against the second material layer to bond the pad components to the second material layer also bonds the first material layer to the second material layer.

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